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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY
OF
MODEL RURAL DEVELOPMENT
IN
NAM DAN DISTRICT, NGHE AN PROVINCE

FINAL REPORT

SUPPORTING REPORT

FEBRUARY, 1998

PACIFIC CONSULTANTS INTERNATIONAL
PASCO INTERNATIONAL INC.

THE SOCIALIST REPUBLIC OF VIET NAM
MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT (MARD)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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APPENDIX-A METEOROLOGY AND HYDROLOGY

A.1 Introduction

A.1.1 Objective of the Study

The main objective of the meteo-hydrological study is to clarify the meteo-hydrological conditions in the Study Area for the Study on the Model Rural Development in Nam Dan District of Nghe An Province (hereinafter referred to as "the Study").

The existing meteo-hydrological data and information were collected, and the field survey and investigation were carried out. Some studies and analyses were also carried out based on the data and information collected and the field survey conducted to the extent that the principal meteorological and hydrological features of the respective basins and areas were clarified.

The results of the Study are presented below.

A.1.2 Summary of the Study

(1) Field Work

The works carried out during the Field Work are summarized below.

- Data collection	Rainfall data	(14 stations)
	Meteorological data	(2 stations)
	Hydrological data	(15 stations)

- Preliminary data analysis and technology transfer
- Other field investigations

(2) Summary of Meteorology

The meteorological parameters observed in the meteorological station at Vinh in Nghe An Province which is nearest station of the study area are summarized below.

- Annual rainfall	2,133 mm
- Mean Temperature	24 °C
- Average Maximum Temperature	33 °C
- Average Minimum Temperature	17 °C
- Relative humidity	85 %
- Wind velocity	1.9 m/s
- Sunshine	4.7 hr/day
- Evaporation	940 mm/year

(3) Summary of Hydrology

The correlation coefficients of monthly rainfall were calculated for every two stations as shown in Table A.4.1. Each station has a correlation coefficient of more than 75% with its neighboring stations.

Considering the data availability and locations, Nam Dan and Nam Phúc stations were selected for the rainfall analysis for the Study area. Rainfall Pattern at the stations are shown below.

(unit :mm)

Name of Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Nam Phú c	40	32	42	71	202	115	171	199	502	364	193	49	1,980
Nam Dan	26	28	36	65	136	149	125	230	431	409	130	45	1,811

More than 85% of the annual rainfall is expected to occur during the period from June to November, and the rainfall at Southern part of the District is expected to be higher than Northern pat.

The probability analysis was carried out on the following items and the results are Summarized below;

	Station Nam Dan			Station Nam Phuc		
Return Period	Annual Rainfall (mm)	Maximum 24 hr Rainfall (mm)	Consecutive Days without Rainfall (less than 5.0 mm)	Annual Rainfall (mm)	Maximum 24 hr Rainfall (mm)	Consecutive Days without Rainfall (less than 5.0 mm)
1/100	1,075.8	446.1	88	1,226.1	569.0	92
1/50	1,143.9	406.7	82	1,263.6	494.5	81
1/10	1,360.7	311.5	67	1,410.8	338.7	59
1/5	1,502.2	266.5	59	1,531.8	277.0	50
1/2	1,815.2	195.7	47	1,877.7	195.6	40

River specific discharges at 12 stations which have discharge record were analyzed and their runoff pattern are summarized as below;

Runoff Pattern (l/s/km^2)

Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
COC NA	LAM	417	20	15	15	14	19	26	31	40	90	82	54	28	435
CUA RAO	LAM	12,800	7	6	5	5	8	19	29	45	47	26	15	9	222
DUA	LAM	20,800	8	7	6	6	10	18	24	39	53	45	20	11	246
YEN THUONG	LAM	22,300	9	7	6	6	11	18	25	41	57	54	25	12	273
HUONG DAI	NGAN TRUOI	408	52	37	33	29	33	45	50	67	140	191	149	76	901
HOA DUYET	NGAN SAU	1,880	38	28	26	24	36	34	36	49	162	195	102	54	785
KHE LA	KHE THIEM	28	8	8	6	7	6	11	16	26	75	78	21	10	272
MUONG XEN	NAM MO	2,620	10	8	7	7	13	27	48	63	55	33	18	12	304
NGHIA DAN	HIEU	3,970	11	9	8	8	14	27	35	41	75	73	32	17	349
NGHIA KHANH	HIEU	4,000	16	13	12	12	20	28	29	49	84	84	33	19	400
QUY CHAU	HIEU	1,500	28	24	20	20	34	52	57	79	116	109	57	37	632
SON DIEM	NGAN PHO	790	39	30	28	28	39	42	41	55	171	149	97	53	771

At Lam River, the amount of river discharge is rising up from July and the maximum discharge is observed in October. The low flow season starts from January and lasts until May. Comparing with rainfall pattern at Nam Dan district, the high and the low flow seasons occur with one (1) month delay from the rainy and the dry seasons, respectively. About 75% of annual runoff occurs during the period from July to November, and 50% during the period from September to November. Discharge during March and April are considered to be the lowest.

The relationship between catchment area and annual runoff, minimum and maximum were analyzed and following equation are expected as the relation between catchment area and annual runoff:

Runoff (mm/year) = 10773*[Catchment Area (km^2)]$^{-0.285}$
Minimum Specific Discharge ($l/s/km^2$) = 117.6*[Catchment Area (km^2)]$^{-0.241}$
Maximum Specific Discharge ($l/s/km^2$) = 3435*[Catchment Area (km^2)]$^{-0.411}$

Based on the 23 years of discharge record at the Yen Thuong station which is the nearest station to Nam Dan District at Lam river, mean, low and high flow were analyzed and the results are summarized as below;

STATION YEN THUONG			
Return Period	Mean Discharge (m^3/s)	Maximum Discharge (m^3/s)	Minimum Discharge (m^3/s)
1/200	219.2	10,901.8	44.0
1/100	235.9	9,785.0	46.6
1/50	255.8	8,696.5	49.8
1/10	323.3	6,241.3	61.0
1/5	370.4	5,173.4	69.1
1/2	482.5	3,626.9	89.2

There are several tributaries in the Study area and the direct runoff from the rainfall is drained through these tributaries. The amount of the peak runoff should be varied depending on the scale of catchment area. Therefore, the peak runoff discharge was analyzed applying the Rational Formula.

Based on the discharge and suspended sediment record at the Yen Thuong, suspended sediment runoff was analyzed and result are summarized as below;

Summary of Suspended Sediment Runoff (ton/km^2)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	1.1	0.7	0.8	0.9	3.8	6.7	17.2	33.1	45.1	31.3	6.3	1.8	148.8
Max.	7.5	5.0	2.9	3.2	26.8	25.2	70.6	109.6	184.3	81.6	28.3	6.9	365.4
Min.	0.2	0.1	0.1	0.1	0.5	0.6	0.4	2.4	2.3	1.0	0.1	0.0	51.6

A.2 Data Collection and Data Availability

A.2.1 Data Collection

There are 14 rainfall stations, 2 meteorological stations and 14 hydrological stations in and around the Nam Dan District as shown in Fig. A.2.1 and Table A.2.1. The monthly meteorological and hydrological parameters for those stations were corrected and those parameters are summarized as shown in Table A.2.2. Considering the locations and data availability, daily rainfall data at Nam Dan and Nam Phúc, daily water level at Nam Dan and Yen Thuong and daily discharge data at Yen Thuong were corrected.

A.2.2 Availability of Meteo-hydrological Data

The availability of meteo-hydrological data is shown in Fig A.2.2.

A.3 Meteorology

Summary of climate conditions at Vinh and Do Luong are summarized as shown in Fig. A.3.1.

A.3.1 Rainfall

While rainfall occurs throughout a year in the Nam Dan District, it is extremely variable and undependable. The seasonal rainfall pattern at 16 stations are shown in Fig. A.3.2.

The mean monthly rainfall is higher from June to November than that from December to May, and these two (2) periods are generally referred to as the rainy and the dry seasons, respectively. More than 60 % of annual rainfall is expected from August to October, and about 80 % of annual rainfall is observed from June to November.

A.3.2 Temperature

The monthly temperature data at Vinh is summarized as below:

Summary of Temperature in Vinh

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean T (°C)	17.4	18.0	20.4	24.0	27.7	29.4	29.6	28.6	26.9	24.3	21.6	18.8	23.9
Max. T (°C)	26.2	27.8	31.6	35.7	37.7	37.6	37.8	36.9	34.7	31.6	29.5	27.3	32.9
Mini. T (°C)	9.9	11.3	13.6	16.9	20.8	23.1	23.6	23.5	21.7	18.1	14.1	10.7	17.3

The mean, maximum and minimum annual temperature was estimated as 24 °C, 33 °C and 17 °C respectively. The temperature in May to September is quite high throughout the year.

A.3.3 Other Parameters

(1) Relative Humidity

The monthly average relative humidity (%) in Vinh was estimated as shown below.

Summary of Relative Humidity (%)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
89.2	91.1	91.2	88.7	81.2	75.6	73.9	80.1	86.2	87.2	86.6	86.7	84.8

The mean annual relative humidity was estimated as 85%. The relative humidity at Vinh seems not vary throughout a year.

(2) Sunshine

The monthly average of sunshine duration (hr/day) at Vinh is shown below.

Summary of Sunshine (hr/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
2.5	1.7	2.4	4.4	7.5	6.8	7.7	6.6	5.6	5.2	3.5	3.1	4.7

The mean annual duration of sunshine was estimated as 4.7 hr/day. The mean monthly duration of sunshine is generally higher during the period from May to October than other months.

(3) Wind Velocity

The average monthly mean wind velocity (m/sec) in Vinh is calculated as shown below.

Summary of Wind Velocity (m/s)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1.8	1.8	1.7	1.9	2.0	2.4	2.5	1.9	1.5	1.8	1.7	1.7	1.9

The mean annual wind velocity was estimated as 1.9 m/sec. The wind velocity during the period from May to July is higher than that of other months.

(4) Evaporation

The annual mean monthly evaporation (mm/day) in Vinh is shown below.

Summary of Evaporation (mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1.3	1.0	1.2	1.8	3.5	5.0	5.7	3.9	2.2	2.0	1.8	1.7	2.6

The mean annual evaporation is estimated as 2.6 mm/day. The mean monthly evaporation is higher during the period from May to August than that from September to February.

A.4 Hydrology

A.4.1 General

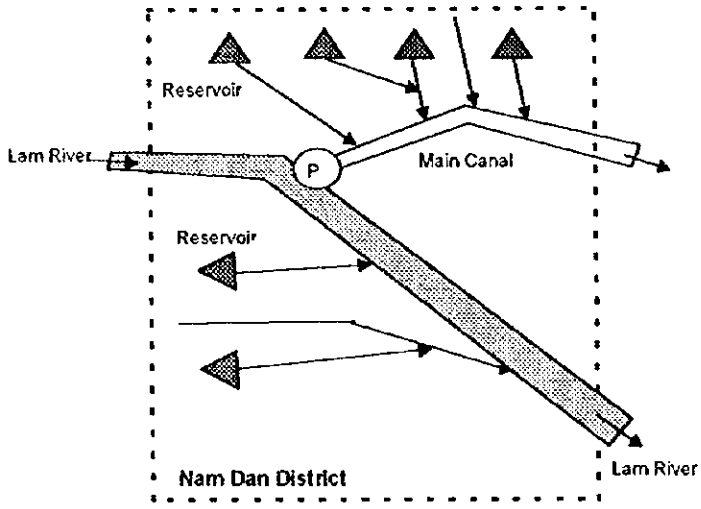
The Lam River which is one of main rivers in Nghe An Province is flowing down in the Nam Dan District from the central of western part to southern part. Approximately 500 m^3/s of annual mean discharge of the Lam River is estimated based on the discharge record at the Yen Thuong hydrological station with 22,300 km^2 of its' catchment area. The highest flow season is observed at the period August to October with more than 800 m^3/s of monthly mean discharge. The lowest flow season is occurred from February to April with less than 200 m^3/s.

Nam Dan District is divided into two zones such as North-eastern and South-western part by the Lam River. All tributaries which originated at mountainous area of Western part of the District are flowing into the Lam River.

There is the main canal under the South Nghe An Irrigation Project supported by World Bank at the central part of the District and flowing from Nam Dan sluice to Ben Thuy Sluice with 33.2 m^3/s of flow capacity. Most of all tributaries originated at mountainous area at North part of the District are flowing into this main canal.

There are several reservoirs at mountain foot of the Northern and Western parts of the District and total water storage capacities of reservoirs are more than 100,000 m^3.

The drainage system of the Nam Dan District is illustrated as shown below.



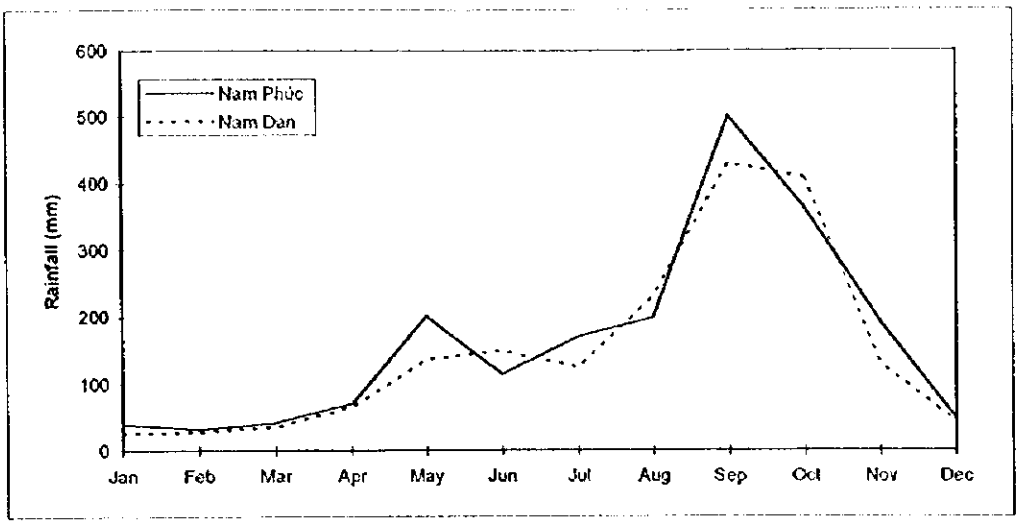
A.4.2 Rainfall Analysis

(1) Correlation Coefficient of Monthly Rainfall among the Stations

The correlation coefficients of monthly rainfall were calculated for every two stations as shown in Table A.4.1. Each station has a correlation coefficient of more than 75% with its neighboring stations.

(2) Rainfall Pattern at Nam Dan and Nam Phúc Stations

Considering the data availability and Locations, Nam Dan and Nam Phúc Stations were selected for the rainfall analysis for the Study area. Rainfall Pattern at these stations are shown below.



More than 85% of the annual rainfall is expected to occur during the period from June to November, and the rainfall at Southern part of the District is expected to be higher than Northern pat.

(3) Probability Analysis

The probability analysis was carried out on the following items and the results are shown below:

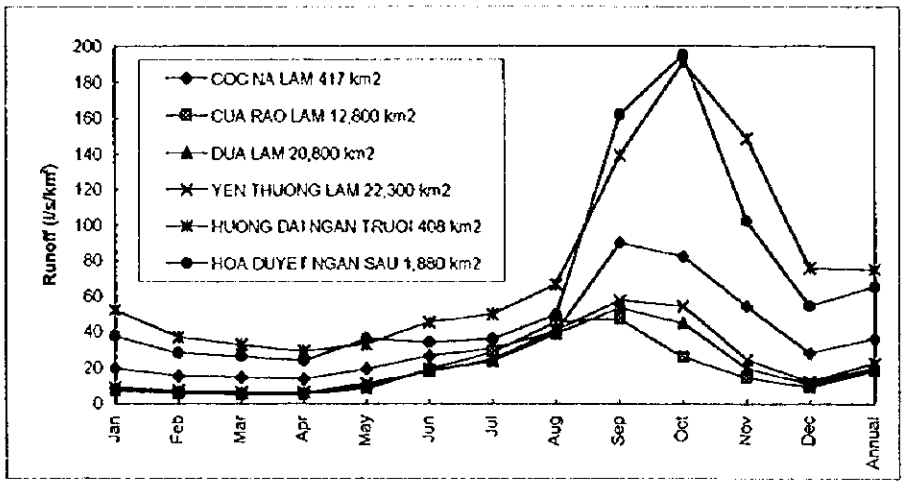
Station Nam Dan					
Return Period	Annual Rainfall (mm)	Maximum 24 hr Rainfall (mm)	Maximum 3 days Rainfall (mm)	Consecutive Days without Rainfall (less than 0.1 mm)	Consecutive Days without Rainfall (less than 5.0 mm)
1/200	1,017.0	485.3	755.6	83	93
1/100	1,075.8	446.1	687.9	73	88
1/50	1,143.9	406.7	621.3	64	82
1/10	1,360.7	311.5	468.2	44	67
1/5	1,502.2	266.5	400.0	37	59
1/4	1,559.8	250.9	377.0	34	57
1/2	1,815.2	195.7	298.8	26	47
Station Nam Phuc					
Return Period	Annual Rainfall (mm)	Maximum 24 hr Rainfall (mm)	Maximum 3 dais Rainfall (mm)	Consecutive Days without Rainfall (less than 0.1 mm)	Consecutive Days without Rainfall (less than 5.0 mm)
1/200	1,196.9	648.5	1,161.6	69	104
1/100	1,226.1	569.0	1,021.0	65	92
1/50	1,263.6	494.5	889.1	60	81
1/20	1,332.8	403.2	727.2	53	68
1/10	1,410.8	338.7	612.5	47	59
1/5	1,531.8	277.0	502.7	41	50
1/4	1,587.1	257.5	467.9	39	48
1/2	1,877.7	195.6	357.4	30	40

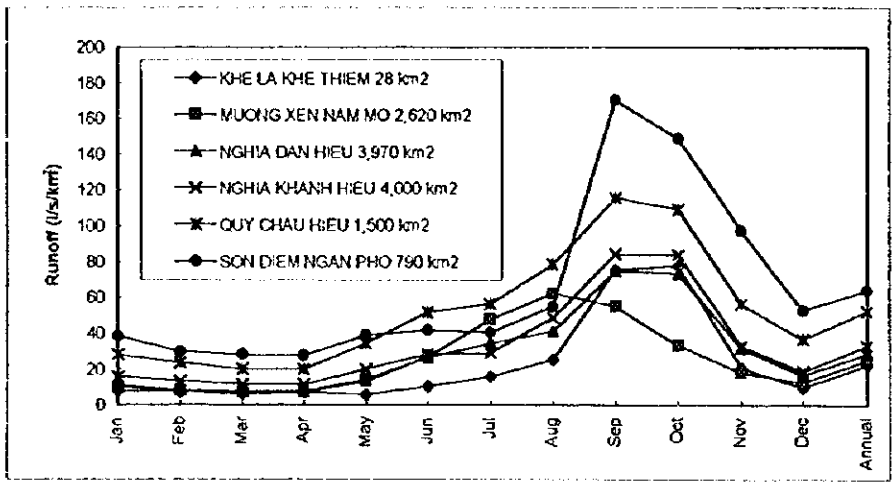
A.4.3 Runoff Analysis

(1) Characteristics of Runoff

1) River Discharge at Selected Stations

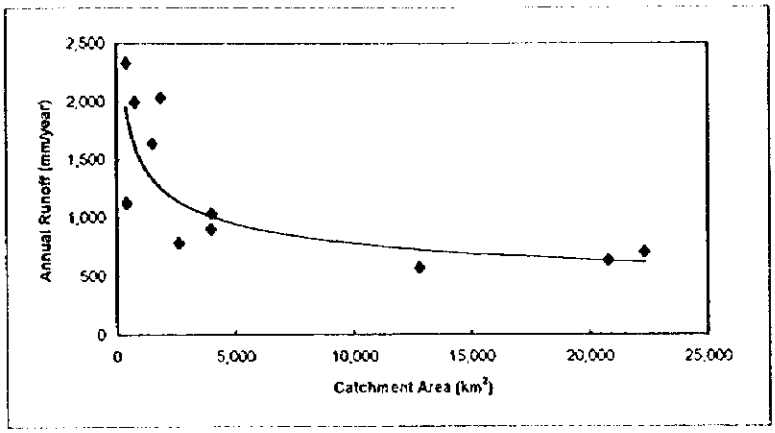
River specific discharges at 12 stations which have discharge record are summarized in Table A.4.2, and their runoff pattern are summarized as below;





At Lam River, the amount of river discharge is rising up from July and the maximum discharge is observed in October. The low flow season starts from January and lasts until May. Comparing with rainfall pattern at Nam Dan district, the high and the low flow seasons occur with one (1) month delay from the rainy and the dry seasons, respectively. About 75% of annual runoff occurs during the period from July to November, and 50% during the period from September to November. Discharge during March and April are considered to be the lowest.

The relationship between catchment area and annual runoff is shown below;



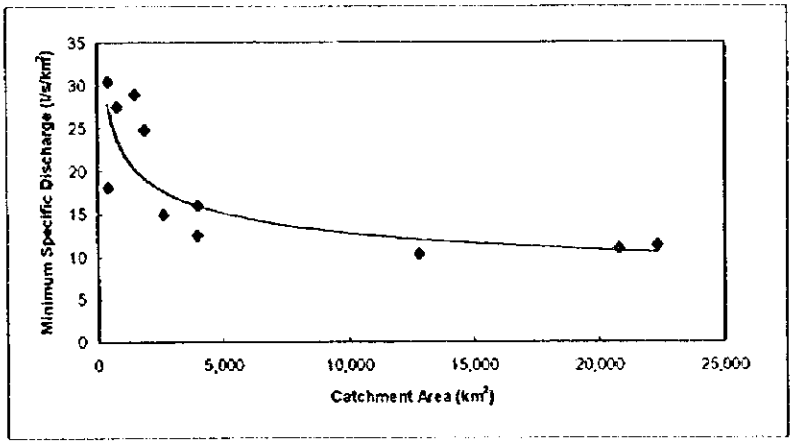
Following equation is expected as the relation between catchment area and annual runoff:

Runoff (mm/year) = 10773*[Catchment Area (km^2)]$^{-0.285}$

(2) Low Flow Analysis

1) Relation between Low Flow and Catchment Area

Based on the discharge record at 12 stations around the Nam Dan District, relationship between specific discharge and catchment area for low flow was analyzed as below;



Following equation is expected as the relation between catchment area and annual runoff:

Minimum Specific Discharge (l/s/km^2) = 117.6*[Catchment Area (km^2)]$^{-0.241}$

2) Probability Analysis for Low Flow

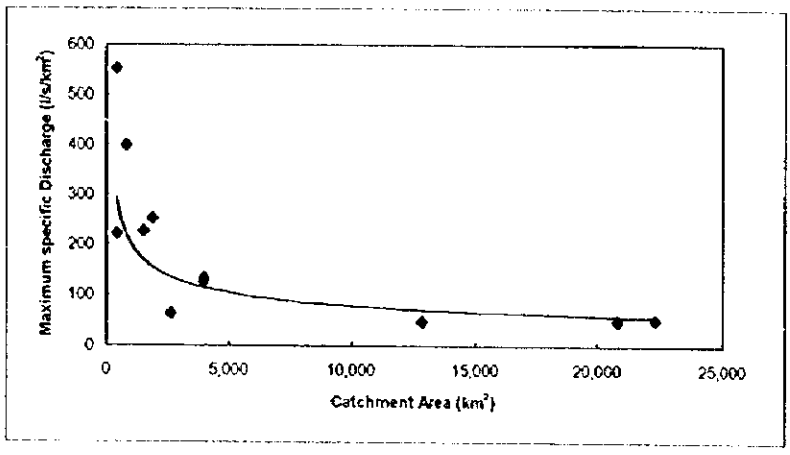
Based on the 23 year of discharge record at the Yen Thong station which is the nearest station to Nam Dan District at Lam River, low flow was analyzed and the results are summarized as shown below;

STATION YEN THUONG		
Return Period	Mean Discharge (m^3/s)	Minimum Discharge (m^3/s)
1/200	219.2	44.0
1/100	235.9	46.6
1/50	255.8	49.8
1/20	289.4	55.3
1/10	323.3	61.0
1/5	370.4	69.1
1/4	390.2	72.5
1/2	482.5	89.2

(3) High Flow Analysis

1) Relation between High Flow and Catchment Area

Based on the discharge record at 12 stations around the Nam Dan District, relationship between specific discharge and catchment area for high flow was analyzed as below;



Following equation is expected as the relation between catchment area and annual runoff:

Maximum Specific Discharge ($l/s/km^2$) = 3435*[Catchment Area (km^2)]$^{-0.411}$

2) Probability Analysis for High Flow

Based on the 23 year of discharge record at the Yen Thuong, high flow was analyzed and the results are summarized as shown below;

STATION YEN THUONG	
Return Period	Maximum Discharge (m^3/s)
1/200	10,901.8
1/100	9,785.0
1/50	8,696.5
1/20	7,293.0
1/10	6,241.3
1/5	5,173.4
1/4	4,819.0
1/2	3,626.9

3) Direct Runoff from Rainfall

There are several tributaries in the Study area and the direct runoff from the rainfall is drained through these tributaries. The amount of the peak runoff should be varied depending on the scale of catchment area. Therefore, the peak runoff discharge was analyzed applying the Rational Formula described below;

$$Qf = f\,I\,A/3.6$$

Where Qf : Peak flood discharge (m^3/s)
f : Flood runoff coefficient (considering the condition of the Study area, a coefficient of 0.7 was applied)
I : Rainfall intensity on the duration time (mm/hr)
A : Catchment area (km^2)

Due to a lack of hourly rainfall data, rainfall intensity was estimated using the following formula:

$$I = R_{24}/24\,(24/T)^{n}$$

Where R_{24} : Maximum 24 hr rainfall (mm)
T : Duration time (hr)
n : Coefficient (considering the condition of the Study area, a coefficient of 1/2 was applied)

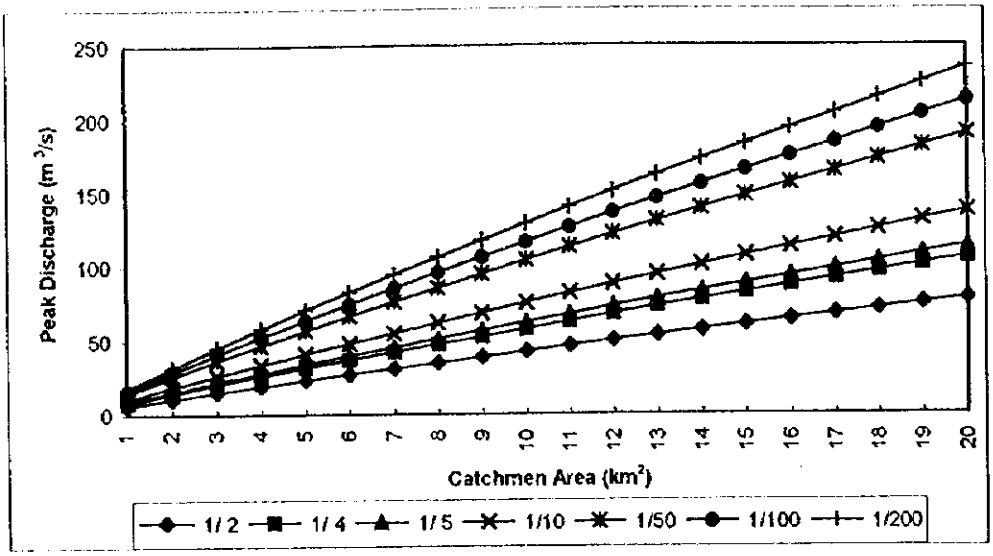
The time duration should be varied depending on the condition of catchment area. Therefore, time duration was estimated using the following formula:

$$Tp = C\,A^{(0.22)}\,I^{(-0.35)}$$

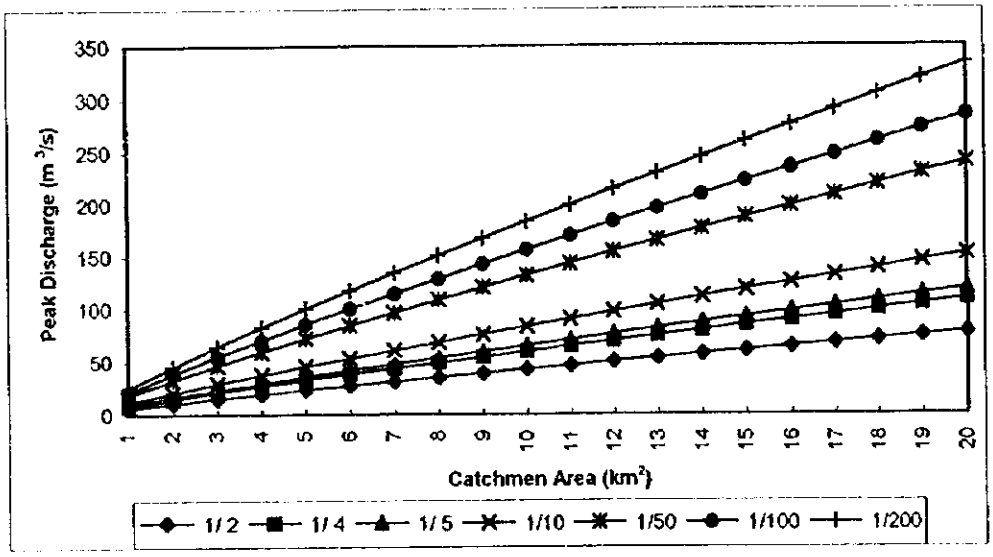
Where Tp : Time duration in minutes (min)
C : Coefficient (considering topographic and land use condition in the Study area, a coefficient of 350 was applied)

Using those formula and Maximum rainfall at Nam Dan and Nam Phúc, the peak runoff discharge for average year was estimated as shown below;

Station Nam Dan



Station Nam Phúc



A.4.4 Sediment Runoff Analysis

Based on the discharge and suspended sediment record at the Yen Thuong, sediment runoff was analyzed and result are summarized as shown below;

Summary of Suspended Sediment Runoff (ton/km²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	1.148	0.727	0.810	0.888	3.769	6.662	17.248	33.091	45.091	31.303	6.256	1.777	148.770
Max.	7.484	4.964	2.927	3.205	26.836	25.175	70.579	109.638	184.284	81.609	28.343	6.872	365.436
Min.	0.177	0.080	0.096	0.078	0.495	0.637	0.375	2.355	2.347	1.000	0.099	0.025	51.644

APPENDIX A: TABLES

Table A.2.1 List of Meteo-hydorological Stations in and around Nam Dan District

(1) LIST OF RAINFALL STATION				
No.	Name of Stations	Latitude	Longitude	Period
1	Nghi Loc	18 ° 47 'N	105 ° 39 'E	1961-1994
2	Than Dong	18 ° 48 'N	105 ° 20 'E	1961-1994
3	Nghi Quang	18 ° 42 'N	105 ° 40 'E	1961-1994
4	Nghi Van	18 ° 53 'N	105 ° 32 'E	1961-1994
5	Cho Trang	18 ° 34 'N	105 ° 38 'E	1961-1994
6	Thanh Minh	18 ° 43 'N	105 ° 22 'E	1961-1994
7	Dai Son	18 ° 50 'N	105 ° 27 'E	1961-1994
8	Nam Phuc	18 ° 36 'N	105 ° 35 'E	1961-1994
9	Linh Cam	18 ° 31 'N	105 ° 34 'E	1961-1994
10	Son Pho	18 ° 31 'N	105 ° 25 'E	1961-1994
11	Son Le	18 ° 34 'N	105 ° 21 'E	1961-1994
12	Yen Thuong	18 ° 41 'N	105 ° 23 'E	1961-1994
13	Nam Dan	18 ° 42 'N	105 ° 29 'E	1961-1994
14	Nghi Lam	18 ° 48 'N	105 ° 35 'E	1961-1994

(2) List of Meteorological Stations				
No.	Name of Stations	Latitude	Longitude	Period
15	Vinh	18 ° 40 'N	105 ° 40 'E	1956-1989
16	Do Lung	18 ° 54 'N	105 ° 18 'E	1956-1990

(3) List of Hydrological Stations									
No.	Name of Stations	Latitude	Longitude	Period	Catchment Area (km^2)	River	Water Level	Discharge	Suspended Sediment
1	COC NA	19 ° 5 'N	104 ° 45 'E	1961-1976	417	LAM	O	O	O
2	CON CUONG	19 ° 4 'N	104 ° 48 'E	1960-1976	-	LAM	O		
3	CUA RAO	19 ° 17 'N	104 ° 51 'E	1959-1994	12,800	LAM	O	O	O
4	DO LUONG	18 ° 54 'N	105 ° 54 'E	1965-1976	-	LAM	O		
5	DUA	18 ° 59 'N	105 ° 57 'E	1959-1981	20,800	LAM	O	O	O
6	YEN THUON	18 ° 41 'N	105 ° 91 'E	1968-1994	22,300	LAM	O	O	O
7	NAM DAN	18 ° 42 'N	105 ° 76 'E	1961-1994	-	LAM	O		
8	HUONG DAI	18 ° 23 'N	105 ° 60 'E	1970-1985	408	NGAN TRUOI	O	O	
9	HOA DUYET	18 ° 22 'N	105 ° 63 'E	1969-1994	1,880	NGAN SAU	O	O	O
10	KHE LA	19 ° 0 'N	105 ° 66 'E	1959-1972	28	KHE THIEM	O	O	
11	MUONG XE	19 ° 24 'N	104 ° 73 'E	1972-1994	2,620	NAM MO	O	O	
12	NGHIA DAN	19 ° 19 'N	105 ° 79 'E	1961-1981	3,970	HIEU	O	O	O
13	NGHIA KHA	19 ° 15 'N	105 ° 82 'E	1968-1994	4,000	HIEU	O	O	O
14	QUY CHAU	19 ° 23 'N	105 ° 85 'E	1961-1994	1,500	HIEU	O	O	O
15	SON DIEM	18 ° 30 'N	105 ° 88 'E	1961-1994	790	NGAN PHO	O	O	O

Table A.2.2 Summary of Meteo-hydrological Data (1/4)

(1) Summary of Rainfall Data (mm)

No.	Name of Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Nghi Loc	34.7	33.4	37.1	52.4	151.3	112.2	114.1	238.2	488.9	480.2	130.6	55.4	1928.5
2	Than Dong	47.4	34.4	45.6	96.4	184.9	152.1	115.9	225.6	427.9	504.8	127.3	78.8	2041.0
3	Nghi Quang	26.1	42.2	30.1	50.5	107.8	65.0	57.6	230.5	604.3	331.9	142.3	68.5	1756.7
4	Nghi Van	17.6	22.0	29.9	67.9	157.3	166.8	104.3	225.6	604.4	493.4	151.3	85.0	2125.4
5	Cho Trang	40.1	33.2	42.1	63.6	123.7	119.2	106.7	211.2	485.5	553.5	176.4	71.0	2026.1
6	Thanh Minh	58.0	41.6	63.9	92.7	194.3	157.1	107.2	235.3	522.4	291.8	153.0	80.1	1997.6
7	Dai Son	28.3	27.9	37.3	90.2	153.5	139.8	112.1	243.4	497.3	376.8	127.9	42.2	1876.7
8	Nam Phuc	40.3	32.2	42.0	70.9	201.7	115.2	171.2	198.5	501.8	363.8	193.5	48.9	1979.9
9	Linh Cam	34.5	27.8	39.9	64.8	150.0	133.2	136.9	209.1	471.9	474.4	147.5	57.1	1947.1
10	Son Pho	51.3	41.3	53.8	73.6	182.7	157.8	142.1	273.9	574.6	393.3	147.7	72.2	2164.3
11	Son Le	40.9	30.1	43.5	80.7	147.4	133.9	134.3	196.5	428.4	383.0	124.1	42.5	1785.3
12	Yen Thuong	39.3	38.7	41.8	85.5	170.0	149.2	118.7	252.7	436.5	539.4	131.4	60.8	2064.1
13	Nam Dan	25.9	28.2	35.5	65.5	136.3	149.2	124.9	229.9	430.8	409.1	130.3	45.1	1810.7
14	Nghi Lam	28.1	31.1	41.5	91.9	153.9	122.2	143.0	265.5	465.7	441.5	140.7	37.9	1963.0
15	Vinh	51.5	41.5	45.0	65.0	135.8	120.0	118.3	223.1	522.6	553.7	180.6	76.0	2133.1
16	Do Lung	29.4	31.3	38.0	83.2	156.7	150.6	158.7	250.7	402.2	383.3	106.6	39.7	1830.3

Table A.2.2 Summary of Meteo-hydrological Data (2/4)

(2) Summary of Climate Conditions

No.	STATION : VINH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	MONTHLY RAINFALL (mm)	52	41	45	65	136	120	118	223	523	554	181	76	2133
2	MAXIMUM DAILY RAINFALL (mm)	17.6	12.5	16.3	26.5	61.1	59.2	61.5	94.4	163.1	176.1	61.3	27.4	776.7
3	MONTHLY AVERAGE AIR TEMPERATURE (°C)	17.4	18.0	20.4	24.0	27.7	29.4	29.6	28.6	26.9	24.3	21.6	18.8	286.6
4	HIGHEST AIR TEMPERATURE (°C)	26.2	27.8	31.6	35.7	37.7	37.6	37.8	36.9	34.7	31.6	29.5	27.3	394.4
5	LOWEST AIR TEMPERATURE (°C)	9.9	11.3	13.6	16.9	20.8	23.1	23.6	23.5	21.7	18.1	14.1	10.7	207.4
6	MONTHLY AVERAGE RELATIVE HUMIDITY (%)	89.2	91.1	91.2	88.7	81.2	75.6	73.9	80.1	86.2	87.2	86.6	86.7	1017.6
7	MINIMUM RELATIVE HUMIDITY (%)	50.9	56.4	52.2	48.9	44.2	42.8	42.7	47.2	51.3	51.2	48.6	49.5	585.9
8	MONTHLY TOTAL HOURS OF SUN SHINE	74.9	49.7	71.9	132.2	223.7	204.3	229.6	198.4	168.6	154.5	104.9	93.1	1705.8
9	LOWER LAYER CLOUD COVER (10 scale)	7.8	8.7	8.2	6.5	4.6	4.4	3.6	4.5	4.9	6.0	6.8	7.1	73.1
10	CLOUD COVER (10 scale)	8.4	9.1	8.8	8.1	7.8	8.5	8.0	8.5	7.7	7.5	7.6	7.7	97.7
11	MONTHLY EVAPORATION (mm)	39.4	28.8	37.2	54.3	104.9	151.3	172.2	118.1	67.4	59.5	54.6	51.0	938.6
12	MONTHLY AVERAGE WIND SPEED (m/s)	1.8	1.8	1.7	1.9	2.0	2.4	2.5	1.9	1.5	1.8	1.7	1.7	22.6
No.	STATION : DO LUONG	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	MONTHLY RAINFALL (mm)	29	31	38	83	157	151	159	251	402	383	107	40	1830
2	MAXIMUM DAILY RAINFALL (mm)	10.5	12.6	16.6	32.4	53.0	55.6	70.3	91.8	128.1	139.4	48.0	19.2	677.5
3	MONTHLY AVERAGE AIR TEMPERATURE (°C)	17.5	18.3	20.6	24.3	27.5	28.9	29.1	28.0	26.6	24.3	21.4	18.7	285.3
4	HIGHEST AIR TEMPERATURE (°C)	27.5	29.4	32.6	36.0	37.7	37.5	37.8	36.7	34.8	32.6	30.5	28.3	401.3
5	LOWEST AIR TEMPERATURE (°C)	9.6	10.9	13.5	16.9	20.6	22.9	23.5	23.3	21.6	17.8	14.2	10.5	205.2
6	MONTHLY AVERAGE RELATIVE HUMIDITY (%)	87.1	88.9	89.1	87.6	82.6	79.7	78.2	83.6	87.1	86.4	85.9	85.1	1021.4
7	MINIMUM RELATIVE HUMIDITY (%)	47.4	54.5	51.5	51.5	46.6	47.5	45.1	49.7	51.2	50.0	45.1	45.9	586.0
8	MONTHLY TOTAL HOURS OF SUN SHINE	73.9	52.8	71.2	116.4	189.6	184.7	203.3	167.8	151.2	133.1	102.9	101.7	1548.4
9	LOWER LAYER CLOUD COVER (10 scale)	8.0	8.7	8.5	7.3	5.9	5.8	5.1	5.9	5.9	6.6	7.0	7.3	82.1
10	CLOUD COVER (10 scale)	8.4	9.0	8.8	8.1	7.5	8.1	7.6	8.2	7.5	7.4	7.5	7.7	95.7
11	MONTHLY EVAPORATION (mm)	41.0	34.0	39.2	53.4	87.1	108.3	122.1	84.1	58.0	56.9	52.2	51.7	788.0
12	MONTHLY AVERAGE WIND SPEED (m/s)	1.3	1.3	1.3	1.3	1.3	1.4	1.5	1.3	1.3	1.3	1.2	1.3	15.9

Table A.2.2 Summary of Meteo-hydrological Data (3/4)

(3) Summary of Monthly Water Level Data (cm)

No.	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	1,865	1,859	1,858	1,856	1,863	1,875	1,877	1,887	1,929	1,928	1,906	1,879	1,882
2	CON CUONG	LAM	-	1,562	1,554	1,549	1,551	1,569	1,613	1,646	1,708	1,731	1,679	1,607	1,575	1,612
3	CUA RAO	LAM	12,800	4,351	4,342	4,338	4,339	4,362	4,417	4,462	4,532	4,532	4,462	4,397	4,367	4,408
4	DO LUONG	LAM	-	996	996	994	994	1,001	1,012	1,029	1,067	1,119	1,098	1,009	994	1,026
5	DUA	LAM	20,800	1,138	1,126	1,119	1,119	1,148	1,206	1,244	1,325	1,388	1,347	1,223	1,163	1,212
6	YEN THUONG	LAM	22,300	227	208	196	195	234	284	321	403	471	462	333	257	299
7	NAM DAN	LAM	-	172	152	142	142	179	233	262	328	399	382	279	206	240
8	HUONG DAI	NGAN TRUOI	408	781	769	763	757	760	769	769	781	820	850	838	801	788
9	HOA DUYET	NGAN SAU	1,880	241	223	218	212	232	228	219	243	348	449	339	275	269
10	KHE LA	KHE THIEM	28	4,430	4,430	4,428	4,428	4,427	4,427	4,426	4,431	4,442	4,446	4,437	4,431	4,432
11	MUONG XEN	NAM MO	2,620	6,894	6,888	6,883	6,885	6,903	6,939	6,980	7,004	6,990	6,951	6,919	6,903	6,928
12	NGHIA DAN	HIEU	3,970	3,620	3,609	3,604	3,604	3,631	3,677	3,687	3,721	3,793	3,790	3,697	3,646	3,673
13	NGHIA KHANH	HIEU	4,000	3,452	3,443	3,437	3,435	3,460	3,485	3,483	3,525	3,590	3,588	3,506	3,466	3,489
14	QUY CHAU	HIEU	1,500	5,332	5,317	5,311	5,311	5,336	5,359	5,362	5,390	5,432	5,426	5,368	5,340	5,357
15	SON DIEM	NGAN PHO	790	493	486	484	480	493	493	490	502	566	601	557	518	514

(4) Summary of Monthly Maximum Water Level Data (cm)

No.	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	1,879	1,880	1,882	1,899	1,987	1,987	2,020	2,113	2,238	2,109	2,017	1,900	1,993
2	CON CUONG	LAM	-	1,571	1,566	1,566	1,575	1,653	1,750	1,833	1,934	1,960	1,872	1,669	1,589	1,712
3	CUA RAO	LAM	12,800	4,361	4,351	4,358	4,365	4,444	4,579	4,700	4,796	4,753	4,609	4,436	4,381	4,511
4	DO LUONG	LAM	-	1,002	1,002	1,003	1,004	1,039	1,091	1,186	1,290	1,377	1,352	1,075	1,004	1,119
5	DUA	LAM	20,800	1,153	1,138	1,140	1,148	1,255	1,359	1,464	1,593	1,676	1,630	1,318	1,190	1,339
6	YEN THUONG	LAM	22,300	250	229	228	237	344	421	496	631	693	708	453	299	416
7	NAM DAN	LAM	-	196	172	170	179	283	362	425	527	594	593	392	248	345
8	HUONG DAI	NGAN TRUOI	408	821	795	802	823	867	905	900	1,014	1,149	1,184	1,079	881	935
9	HOA DUYET	NGAN SAU	1,880	288	252	263	270	401	360	348	498	745	852	578	387	437
10	KHE LA	KHE THIEM	28	4,434	4,436	4,435	4,446	4,450	4,463	4,459	4,495	4,541	4,579	4,465	4,443	4,470
11	MUONG XEN	NAM MO	2,620	6,901	6,894	6,899	6,910	6,965	7,028	7,121	7,167	7,119	7,017	6,939	6,910	6,989
12	NGHIA DAN	HIEU	3,970	3,636	3,618	3,632	3,667	3,796	3,879	3,950	4,035	4,234	4,329	3,883	3,689	3,862
13	NGHIA KHANH	HIEU	4,000	3,469	3,458	3,464	3,473	3,585	3,607	3,619	3,791	3,924	3,907	3,587	3,488	3,614
14	QUY CHAU	HIEU	1,500	5,341	5,333	5,340	5,366	5,476	5,543	5,572	5,728	5,832	5,806	5,486	5,364	5,516
15	SON DIEM	NGAN PHO	790	526	509	517	531	661	615	617	772	974	1,039	767	588	676

(5) Summary of Monthly Minimum Water Level Data (cm)

No.	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	1,860	1,855	1,853	1,850	1,849	1,856	1,854	1,859	1,872	1,886	1,882	1,870	1,862
2	CON CUONG	LAM	-	1,556	1,549	1,544	1,542	1,547	1,565	1,585	1,619	1,638	1,613	1,584	1,566	1,576
3	CUA RAO	LAM	12,800	4,337	4,337	4,331	4,328	4,334	4,360	4,388	4,428	4,448	4,408	4,377	4,357	4,370
4	DO LUONG	LAM	-	988	989	987	983	985	992	993	998	1,019	1,007	990	986	993
5	DUA	LAM	20,800	1,129	1,119	1,111	1,107	1,112	1,142	1,163	1,202	1,254	1,224	1,181	1,148	1,158
6	YEN THUONG	LAM	22,300	211	195	181	173	183	216	233	277	346	314	278	232	237
7	NAM DAN	LAM	-	153	139	126	119	129	162	183	218	269	260	226	179	180
8	HUONG DAI	NGAN TRUOI	408	764	758	751	745	743	744	740	744	757	782	793	778	758
9	HOA DUYET	NGAN SAU	1,880	219	210	203	195	193	195	184	188	214	256	260	238	213
10	KHE LA	KHE THIEM	28	4,428	4,428	4,427	4,425	4,423	4,422	4,420	4,422	4,429	4,432	4,433	4,429	4,426
11	MUONG XEN	NAM MO	2,620	6,889	6,884	6,879	6,877	6,883	6,905	6,932	6,949	6,949	6,927	6,909	6,898	6,907
12	NGHIA DAN	HIEU	3,970	3,611	3,602	3,595	3,591	3,590	3,615	3,617	3,635	3,666	3,683	3,655	3,631	3,624
13	NGHIA KHANH	HIEU	4,000	3,444	3,437	3,430	3,424	3,427	3,441	3,441	3,451	3,493	3,492	3,476	3,453	3,451
14	QUY CHAU	HIEU	1,500	5,319	5,311	5,304	5,300	5,302	5,319	5,323	5,334	5,359	5,358	5,347	5,330	5,325
15	SON DIEM	NGAN PHO	790	481	476	473	468	466	469	463	466	484	506	509	495	480

Table A.2.2 Summary of Meteo-hydrological Data (4/4)

(7) Summary of Monthly Mean Discharge (m3/s)

No.	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	8	6	6	6	8	11	13	17	38	34	23	12	15
2	CUA RAO	LAM	12,800	91	74	66	67	106	245	369	582	604	333	186	120	237
3	DUA	LAM	20,800	170	138	123	122	201	379	497	808	1,109	932	408	231	426
4	YEN THUONG	LAM	22,300	206	161	141	139	252	402	554	915	1,282	1,211	548	276	507
5	HUONG DAI	NGAN TRUOI	408	21	15	13	12	14	19	20	27	57	78	61	31	31
6	HOA DUYET	NGAN SAU	1,880	71	53	50	45	68	64	67	93	305	367	192	102	123
7	KHE LA	KHE THIEM	28	0	0	0	0	0	0	0	1	2	2	1	0	1
8	MUONG XEN	NAM MO	2,620	26	21	19	20	35	71	126	164	145	88	48	33	66
9	NGHIA DAN	HIEU	3,970	44	34	31	31	57	107	137	164	298	291	126	66	115
10	NGHIA KHANH	HIEU	4,000	64	54	48	47	80	114	117	196	338	336	131	76	133
11	QUY CHAU	HIEU	1,500	43	36	31	30	52	78	85	118	123	164	85	55	79
12	SON DIEM	NGAN PHO	790	30	24	22	22	31	33	32	43	135	118	77	42	51

(8) Summary of Monthly Maximum Discharge (m3/s)

No	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	12	10	13	28	72	63	107	183	316	183	103	19	93
2	CUA RAO	LAM	12,800	105	132	200	113	309	744	1,283	1,706	1,490	721	291	219	610
3	DUA	LAM	20,800	207	167	177	193	552	931	1,586	2,164	2,819	2,529	733	363	1,035
4	YEN THUONG	LAM	22,300	266	209	221	231	664	976	1,462	2,319	2,851	2,878	1,121	419	1,135
5	HUONG DAI	NGAN TRUOI	408	44	28	32	56	90	173	179	353	547	654	448	99	225
6	HOA DUYET	NGAN SAU	1,880	300	78	100	114	294	228	290	591	1,404	1,349	636	317	475
7	KHE LA	KHE THIEM	28	0	1	1	2	2	4	9	21	46	66	4	2	13
8	MUONG XEN	NAM MO	2,620	32	26	32	40	87	196	397	404	399	186	71	39	167
9	NGHIA DAN	HIEU	3,970	56	42	80	89	246	396	683	742	1,465	1,669	440	107	501
10	NGHIA KHANH	HIEU	4,000	85	71	91	98	316	353	563	1,045	1,651	1,722	304	104	533
11	QUY CHAU	HIEU	1,500	57	49	57	85	231	338	446	723	943	866	204	80	340
12	SON DIEM	NGAN PHO	790	50	35	41	58	197	178	163	541	1,186	812	419	102	315

(10) Summary of Monthly Minimum Discharge (m3/s)

No.	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	7	6	5	5	4	6	5	7	10	15	12	9	8
2	CUA RAO	LAM	12,800	79	66	57	52	59	109	161	253	317	194	141	102	133
3	DUA	LAM	20,800	146	122	104	95	105	182	237	352	522	413	279	189	229
4	YEN THUONG	LAM	22,300	167	135	112	101	119	186	219	351	624	469	347	214	254
5	HUONG DAI	NGAN TRUOI	408	14	11	9	8	7	8	7	8	11	21	25	19	12
6	HOA DUYET	NGAN SAU	1,880	49	41	35	31	31	32	23	25	51	88	88	65	47
7	KHE LA	KHE THIEM	28	0	0	0	0	0	0	0	0	0	0	0	0	0
8	MUONG XEN	NAM MO	2,620	23	19	16	15	19	34	61	79	82	56	38	28	39
9	NGHIA DAN	HIEU	3,970	36	30	24	22	22	40	41	58	86	110	76	52	50
10	NGHIA KHANH	HIEU	4,000	54	47	40	36	38	53	53	65	116	116	90	62	64
11	QUY CHAU	HIEU	1,500	37	31	25	23	23	37	40	51	74	73	62	46	43
12	SON DIEM	NGAN PHO	790	22	19	17	16	16	17	14	15	23	39	36	28	22

(11) Summary of Suspended Sediment Data (g/m3)

No.	Name of Station	River	ment Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	8	6	6	6	8	11	13	17	38	34	23	12	15
2	CUA RAO	LAM	12,800	20	22	36	45	212	476	499	528	521	165	43	21	215
3	DUA	LAM	20,800	31	35	40	44	146	217	283	353	338	244	106	36	156
4	YEN THUONG	LAM	22,300	46	41	48	56	105	134	226	273	247	190	96	59	127
5	HOA DUYET	NGAN SAU	1,880	36	37	39	40	87	66	70	117	120	169	92	43	76
6	NGHIA DAN	HIEU	3,970	30	28	32	40	88	129	122	198	264	228	102	32	108
7	NGHIA KHANH	HIEU	4,000	51	51	52	62	125	157	171	249	402	382	83	49	153
8	QUY CHAU	HIEU	1,500	27	26	31	62	111	123	125	192	207	133	53	30	93
9	SON DIEM	NGAN PHO	790	29	33	33	42	79	59	62	95	125	112	53	31	63

Table A.4.1 Correlation Coefficient of Monthly Rainfall among the Stations

		1 STATION : NGHI LOC	2 STATION : THANH DONG	3 STATION : NGHI QUANG	4 STATION : NGHI VAN	5 STATION : CHO TRANG	6 STATION : THANH MINH	7 STATION : DAI SON	8 STATION : NAM PHUC	9 STATION : LINH CAM	10 STATION : SON PHO	11 STATION : SON LE	12 STATION : YEN THUONG	13 STATION : NAM DAN	14 STATION : NGHI LAM	15 STATION : VINH	16 STATION : DO LUONG
1 STATION : NGHI LOC	C.C		81.01%	83.24%	84.62%	90.90%	86.75%	87.29%	81.32%	92.97%	88.52%	90.36%	94.32%	92.21%	91.69%	93.76%	83.45%
	Nd		290	62	53	315	156	182	162	312	163	264	203	315	250	319	319
2 STATION : THANH DONG	C.C			78.51%	90.69%	77.94%	85.87%	86.78%	75.56%	80.60%	82.04%	84.46%	75.91%	79.25%	85.77%	78.90%	75.13%
	Nd			77	44	366	198	232	200	364	191	314	197	359	301	369	370
3 STATION : NGHI QUANG	C.C				93.64%	80.55%	80.24%	86.38%	76.37%	78.91%	80.15%	79.66%		75.39%	89.26%	86.45%	82.73%
	Nd				63	99	76	99	84	100	82	99		96	99	100	100
4 STATION : NGHI VAN	C.C					91.58%	91.06%	94.43%	88.86%	93.43%	90.01%	92.33%		89.95%	93.36%	93.04%	91.24%
	Nd					63	50	63	57	63	62	62		63	62	63	63
5 STATION : CHO TRANG	C.C						80.46%	85.79%	81.94%	94.08%	91.42%	89.75%	93.53%	91.76%	88.90%	95.20%	80.32%
	Nd						227	259	221	395	215	346	207	392	334	401	402
6 STATION : THANH MINH	C.C							87.07%	74.96%	85.28%	82.86%	82.88%	94.95%	86.31%	86.87%	80.19%	88.75%
	Nd							225	194	221	182	226	68	220	210	226	227
7 STATION : DAI SON	C.C								75.28%	88.09%	89.03%	88.31%	92.77%	89.48%	93.13%	84.02%	92.32%
	Nd								223	256	216	260	68	253	241	261	262
8 STATION : NAM PHUC	C.C									82.20%	78.96%	78.45%	85.70%	79.60%	79.05%	78.62%	73.56%
	Nd									219	185	222	63	221	203	224	224
9 STATION : LINH CAM	C.C										94.30%	92.94%	94.55%	93.98%	91.18%	93.23%	84.26%
	Nd										214	345	204	390	332	400	401
10 STATION : SON PHO	C.C											94.11%	95.36%	91.68%	89.81%	88.10%	85.02%
	Nd											216	53	215	197	218	218
11 STATION : SON LE	C.C												92.34%	89.79%	88.38%	87.91%	82.11%
	Nd												156	341	331	351	352
12 STATION : YEN THUONG	C.C													96.79%	93.37%	94.11%	85.22%
	Nd													207	162	210	210
13 STATION : NAM DAN	C.C														91.69%	91.96%	86.10%
	Nd														328	396	397
14 STATION : NGHI LAM	C.C															90.34%	85.80%
	Nd															338	339
15 STATION : VINH	C.C																79.22%
	Nd																407

Note : C.C Correlation Coefficient (%), Nd Number of Data

Table A.4.2 Annual Runoff Pattern

(1) Summary of Monthly Mean Specific Discharge (l/s/km²)

No	Name of Station	River	Catchment Area (km²)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	19.7	15.4	14.8	13.7	19.5	26.4	30.9	40.1	90.1	82.3	54.2	28.3	36.3
2	CUA RAO	LAM	12,800	7.1	5.8	5.1	5.3	8.3	19.2	28.8	45.5	47.2	26.1	14.5	9.4	18.5
3	DUA	LAM	20,800	8.2	6.6	5.9	5.9	9.7	18.2	23.9	38.8	53.3	44.8	19.6	11.1	20.5
4	YEN THUONG	LAM	22,300	9.2	7.2	6.3	6.2	11.3	18.0	24.8	41.0	57.5	54.3	24.6	12.4	22.7
5	HUONG DAI	NGAN TRUOI	408	52.0	36.9	32.6	29.2	33.2	45.4	49.8	66.5	139.5	190.9	148.9	75.7	75.1
6	HOA DUYET	NGAN SAU	1,880	37.6	28.2	26.4	24.0	36.2	34.1	35.8	49.5	162.0	195.2	102.1	54.4	65.5
7	KHE LA	KHE THIEM	28	8.2	7.6	6.4	7.5	6.0	10.6	16.1	25.6	75.5	77.9	20.7	9.9	22.7
8	MUONG XEN	NAM MO	2,620	10.1	8.2	7.2	7.4	13.3	27.2	48.0	62.6	55.3	33.5	18.2	12.5	25.3
9	NGHIA DAN	HIEU	3,970	11.0	8.6	7.8	7.9	14.3	26.8	34.5	41.4	75.1	73.4	31.7	16.6	29.1
10	NGHIA KHANH	HIEU	4,000	15.9	13.5	11.9	11.7	20.1	28.4	29.3	49.0	84.4	84.0	32.9	18.9	33.3
11	QUY CHAU	HIEU	1,500	28.4	23.7	20.4	20.2	34.4	52.0	56.5	78.5	115.5	109.1	56.6	36.9	52.7
12	SON DIEM	NGAN PHO	790	38.5	29.8	28.4	27.8	39.0	41.8	40.7	55.0	170.5	142.0	97.4	52.9	64.2

(2) Summary of Monthly Maximum Specific Discharge (l/s/km²)

No.	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	28.9	24.8	30.8	67.5	173.1	150.1	257.5	440.0	758.2	439.9	246.2	45.8	221.9
2	CUA RAO	LAM	12,800	8.2	10.3	15.6	8.9	24.1	58.1	100.3	133.3	116.4	56.4	22.7	17.1	47.6
3	DUA	LAM	20,800	9.9	8.0	8.5	9.3	26.6	44.7	76.2	104.0	135.6	121.6	35.3	17.5	49.8
4	YEN THUONG	LAM	22,300	11.9	9.4	9.9	10.4	29.8	43.8	65.6	104.0	127.9	129.1	50.3	18.8	50.9
5	HUONG DAI	NGAN TRUOI	408	108.3	68.3	79.2	135.8	221.8	423.9	439.6	865.4	1340.8	1602.3	1099.1	243.6	552.4
6	HOA DUYET	NGAN SAU	1,880	159.5	41.4	53.3	60.7	156.6	121.5	154.4	314.2	746.8	717.4	338.4	168.4	252.7
7	KHE LA	KHE THIEM	28	15.1	19.7	21.3	59.0	83.3	153.8	326.9	751.5	1665.3	2388.0	158.5	67.6	475.8
8	MUONG XEN	NAM MO	2,620	12.3	10.0	12.2	15.2	33.4	74.8	151.7	188.6	152.4	71.0	27.2	14.8	63.6
9	NGHIA DAN	HIEU	3,970	14.2	10.6	20.2	22.3	61.9	99.6	172.0	186.9	369.0	420.3	110.8	26.9	126.2
10	NGHIA KHANH	HIEU	4,000	21.2	17.8	22.6	24.6	78.9	88.2	140.7	261.2	412.8	430.5	75.9	26.0	133.4
11	QUY CHAU	HIEU	1,500	38.0	32.9	38.3	56.6	153.9	225.3	297.2	482.2	628.3	577.1	135.8	53.2	226.6
12	SON DIEM	NGAN PHO	790	63.2	44.4	52.3	73.2	249.1	225.6	206.9	684.5	1501.2	1028.0	529.8	129.1	398.9

(3) Summary of Monthly MinimumSpecific Discharge (l/s/km²)

No.	Name of Station	River	Catchment Area (km2)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	COC NA	LAM	417	15.8	13.4	12.3	10.9	10.6	13.9	12.8	16.2	25.1	35.1	29.4	21.6	18.1
2	CUA RAO	LAM	12,800	6.2	5.1	4.4	4.1	4.6	8.5	12.6	19.7	24.8	15.1	11.0	8.0	10.4
3	DUA	LAM	20,800	7.0	5.9	5.0	4.6	5.1	8.7	11.4	16.9	25.1	19.9	13.4	9.1	11.0
4	YEN THUONG	LAM	22,300	7.5	6.1	5.0	4.5	5.4	8.3	9.8	15.7	28.0	21.0	15.5	9.6	11.4
5	HUONG DAI	NGAN TRUOI	408	34.0	27.9	23.2	19.8	18.2	19.3	17.3	19.0	27.6	51.5	61.5	46.1	30.4
6	HOA DUYET	NGAN SAU	1,880	25.8	22.0	18.4	16.6	16.6	17.0	12.4	13.3	27.2	46.7	47.0	31.5	24.8
7	KHE LA	KHE THIEM	28	6.3	5.4	4.6	3.5	2.5	2.4	1.7	3.2	11.8	14.8	11.4	6.3	6.1
8	MUONG XEN	NAM MO	2,620	8.7	7.2	6.2	5.7	7.1	13.1	23.4	30.3	31.4	21.3	14.4	10.8	15.0
9	NGHIA DAN	HIEU	3,970	9.0	7.5	6.1	5.7	5.6	10.1	10.4	14.6	21.8	27.6	19.2	13.2	12.6
10	NGHIA KHANH	HIEU	4,000	13.6	11.8	10.0	8.9	9.6	13.2	13.2	16.3	29.1	28.9	22.4	15.5	16.0
11	QUY CHAU	HIEU	1,500	24.7	20.4	16.4	15.0	15.5	24.3	26.6	33.7	49.4	48.7	41.4	30.8	28.9
12	SON DIEM	NGAN PHO	790	27.6	24.0	21.2	20.0	20.1	21.2	17.2	19.1	29.3	49.2	45.7	34.9	27.4

APPENDIX A: FIGURES

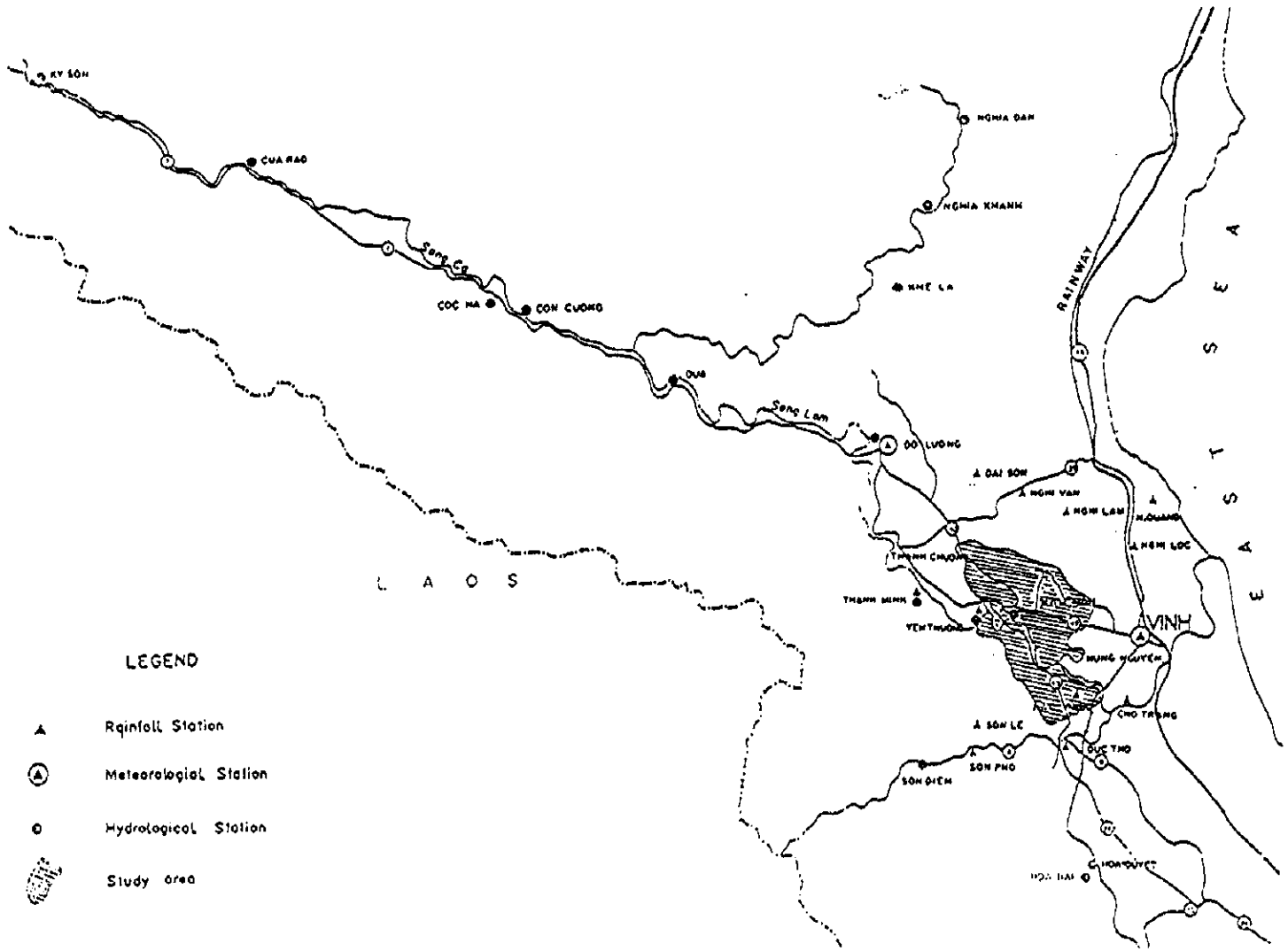


Fig A.2.1 Location of Meteo-hydrological Stations in and around the Study Area

(1) Rainfall Data

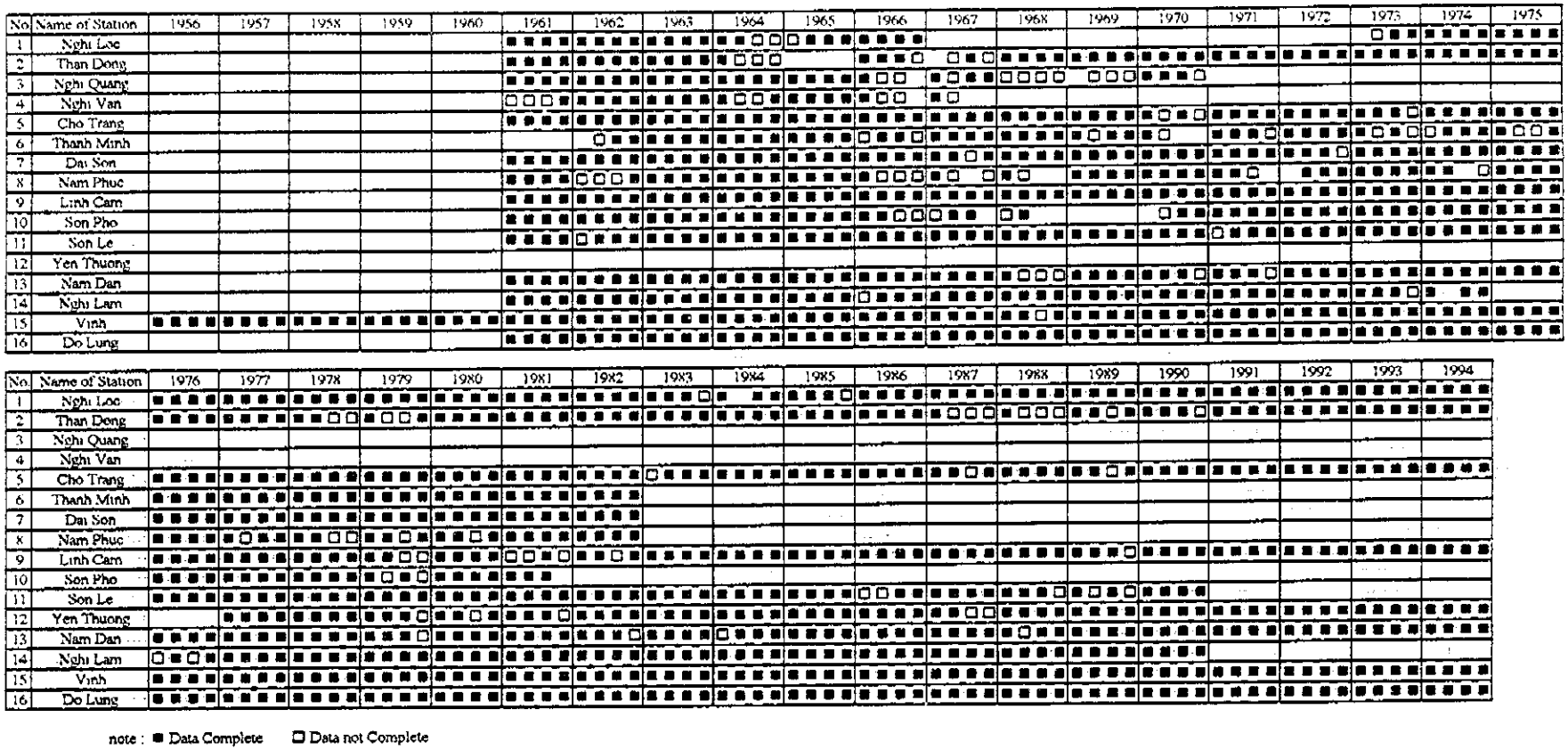


Fig. A.2.2 Barchart of Data Continuity (1/5)

(2) Meteorological Data

STATION : VINH

No.	Parameter	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	MONTHLY RAINFALL (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	MAXIMUM DAILY RAINFALL (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	MONTHLY AVERAGE AIR TEMPERATURE (oC)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
4	HIGHEST AIR TEMPERATURE (oC)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
5	LOWEST AIR TEMPERATURE (oC)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
6	MONTHLY AVERAGE RELATIVE HUMIDITY (%)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
7	MINIMUM RELATIVE HUMIDITY (%)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
8	MONTHLY TOTAL HOURS OF SUN SHINE			■	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■
9	LOWER LAYER CLOUD COVER (10 scale)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
10	CLOUD COVER (10 scale)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
11	MONTHLY EVAPORATION (mm)				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
12	MONTHLY AVERAGE WIND SPEED (m/s)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

No.	Parameter	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	MONTHLY RAINFALL (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	MAXIMUM DAILY RAINFALL (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	MONTHLY AVERAGE AIR TEMPERATURE (o	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
4	HIGHEST AIR TEMPERATURE (oC)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
5	LOWEST AIR TEMPERATURE (oC)	■	■	■	■	■	□	■	■	■	■	■	■	■	■	□	□	■	■	■
6	MONTHLY AVERAGE RELATIVE HUMIDITY	■	■	■	■	■	■	□	■	■	■	■	□	□	■	□	□	■	■	■
7	MINIMUM RELATIVE HUMIDITY (%)	■	■	■	■	■	■	□	■	■	■	■	□	□	■	□	□	■	■	■
8	MONTHLY TOTAL HOURS OF SUN SHINE	■	■	■	■	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■
9	LOWER LAYER CLOUD COVER (10 scale)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
10	CLOUD COVER (10 scale)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
11	MONTHLY EVAPORATION (mm)	■	■	■	■	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■
12	MONTHLY AVERAGE WIND SPEED (m/s)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

STATION : DO LUONG

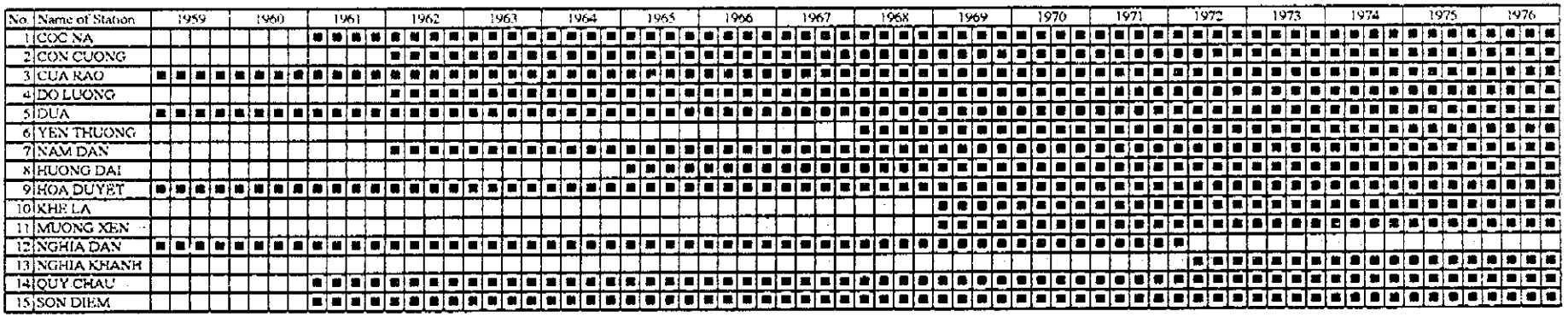
No.	Parameter	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	MONTHLY RAINFALL (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	MAXIMUM DAILY RAINFALL (mm)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	MONTHLY AVERAGE AIR TEMPERATURE (oC)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
4	HIGHEST AIR TEMPERATURE (oC)	□	■	■	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■
5	LOWEST AIR TEMPERATURE (oC)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
6	MONTHLY AVERAGE RELATIVE HUMIDITY (%)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
7	MINIMUM RELATIVE HUMIDITY (%)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
8	MONTHLY TOTAL HOURS OF SUN SHINE					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
9	LOWER LAYER CLOUD COVER (10 scale)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
10	CLOUD COVER (10 scale)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
11	MONTHLY EVAPORATION (mm)	□	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
12	MONTHLY AVERAGE WIND SPEED (m/s)	□	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

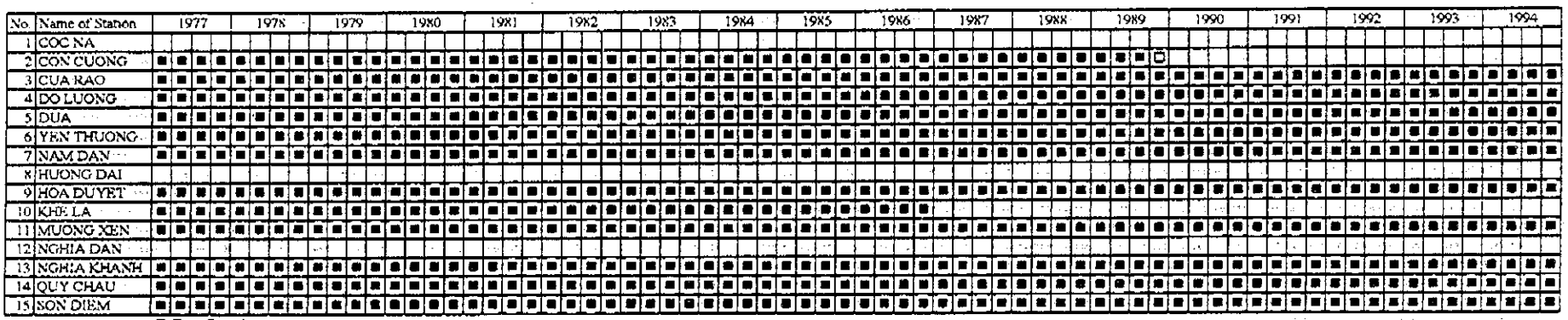
No.	Parameter	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	MONTHLY RAINFALL (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	MAXIMUM DAILY RAINFALL (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	MONTHLY AVERAGE AIR TEMPERATURE (oC)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
4	HIGHEST AIR TEMPERATURE (oC)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
5	LOWEST AIR TEMPERATURE (oC)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
6	MONTHLY AVERAGE RELATIVE HUMIDITY (%)	■	■	□	□	■	■	■	■	■	■	■	■	■	■
7	MINIMUM RELATIVE HUMIDITY (%)	■	■	□	□	■	■	■	■	■	■	■	■	■	■
8	MONTHLY TOTAL HOURS OF SUN SHINE	■	■	■	□	■	■	■	□	■	■	■	■	■	■
9	LOWER LAYER CLOUD COVER (10 scale)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
10	CLOUD COVER (10 scale)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
11	MONTHLY EVAPORATION (mm)	■	■	■	■	■	■	■	■	■	■	■	■	■	■
12	MONTHLY AVERAGE WIND SPEED (m/s)	■	■	■	■	■	■	■	■	■	■	■	■	■	■

note : ■ Data Complete □ Data not Complete

Fig. A.2.2 Bar Chart of Data Continuity (2/5)

(3) Water Level





note : ■ Data Complete
□ Data not Complete

Fig. A.2.2 Bar Chart of Data Continuity (3/5)

(4) River Discharge

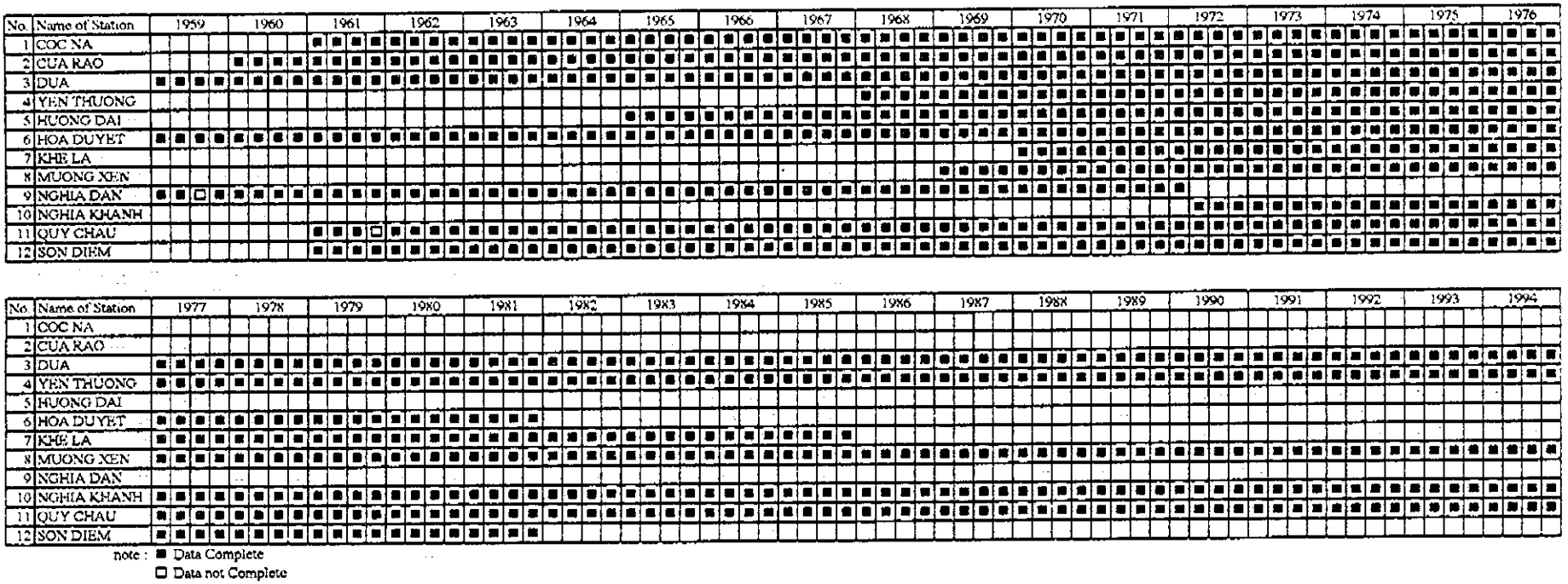
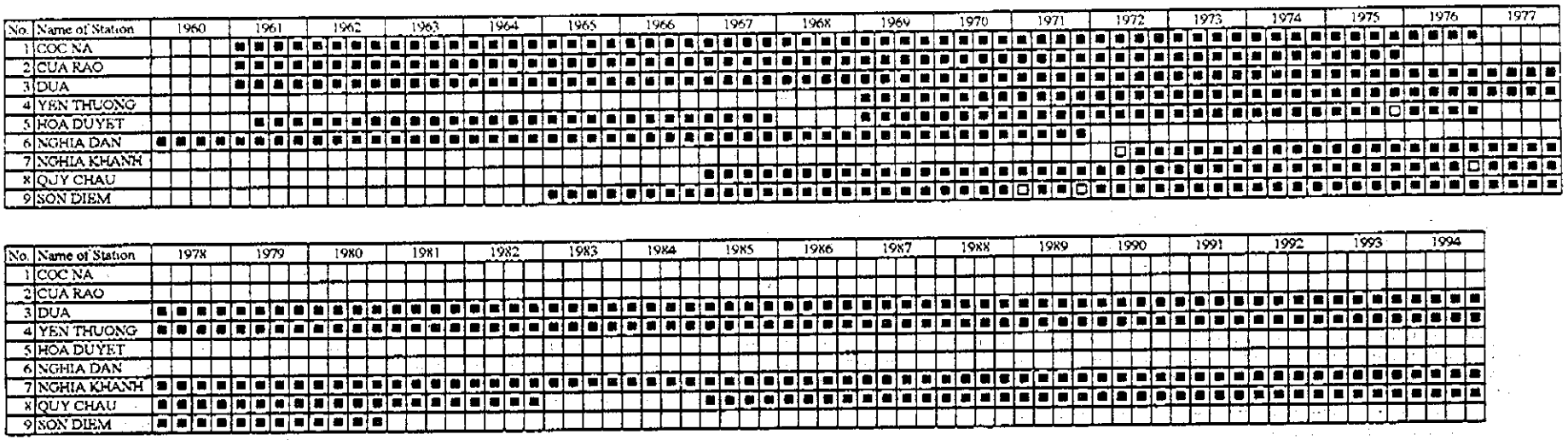


Fig. A.2.2 Bar Chart of Data Continuity (4/5)

(5) Suspended Sediment



note : ■ Data Complete
□ Data not Complete

Fig. A.2.2 Bar Chart of Data Continuity (5/5)

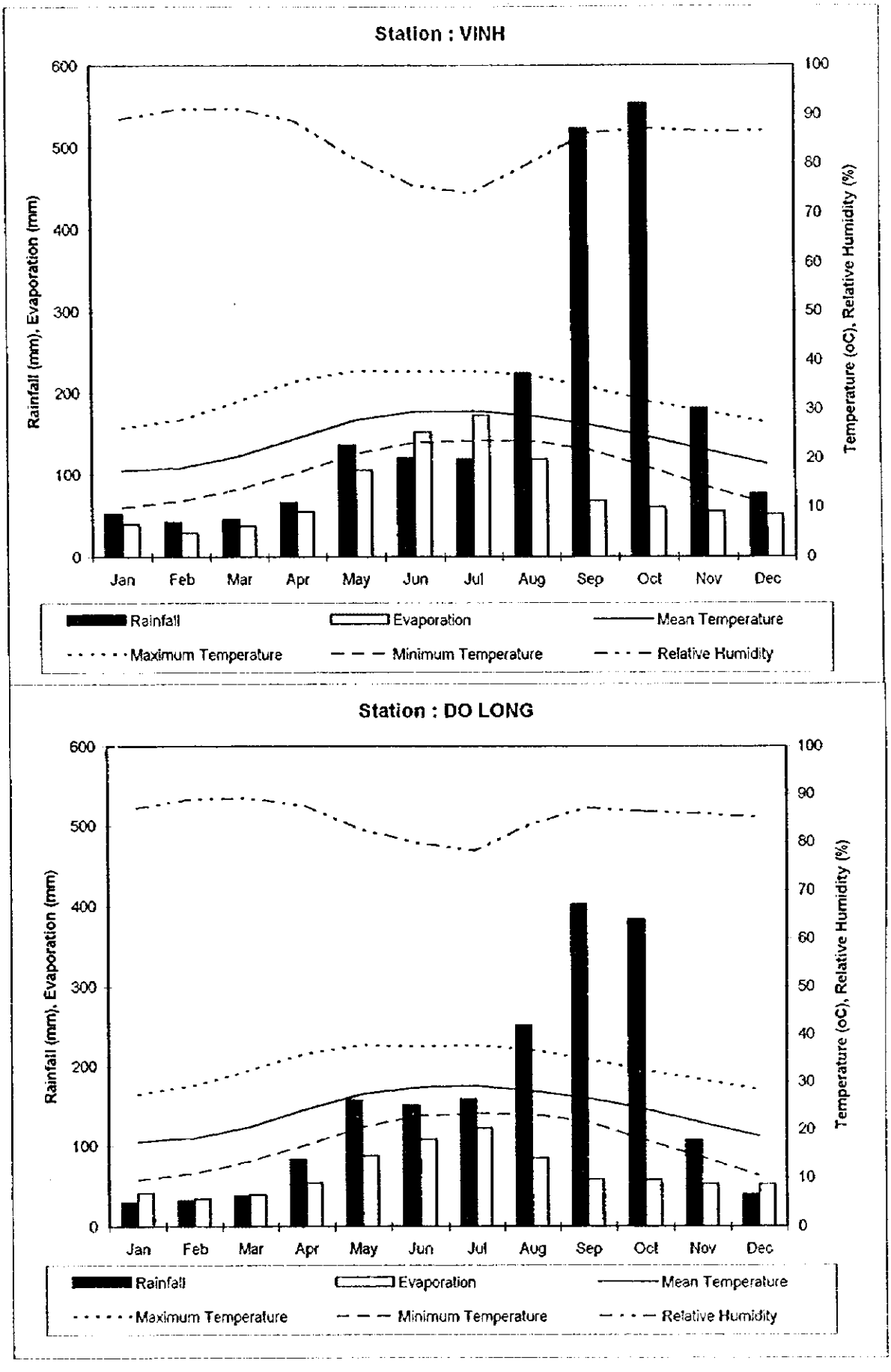


Fig. A.3.1 Climate Conditions in Vinh and Do Long

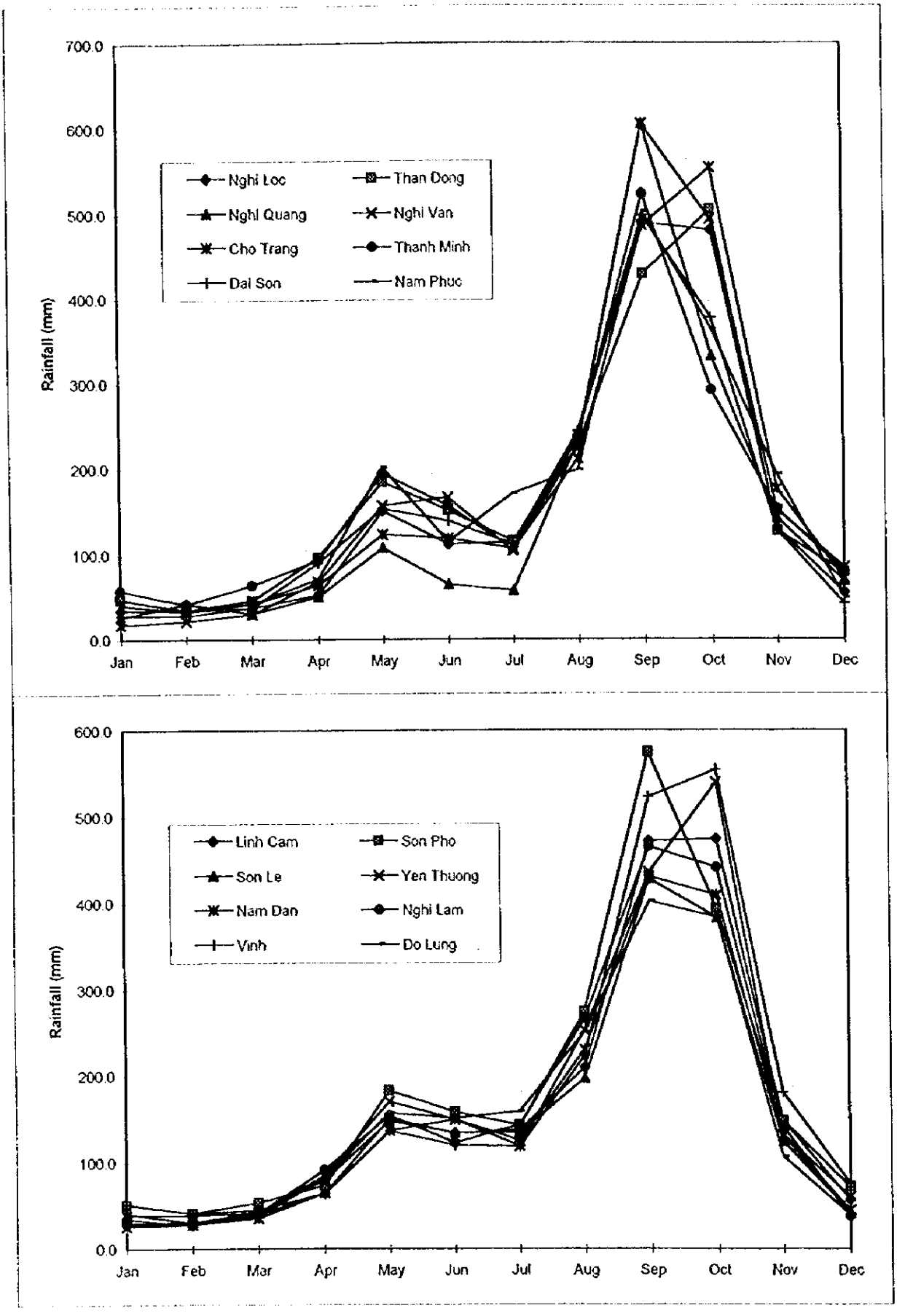


Fig. A.3.2 Annual Rainfall Pattern at 16 Stations

APPENDIX B : AGRICULTURE

THE STUDY
ON
MODEL RURAL DEVELOPMENT
IN
NAM DAN DISTRICT, NGHE AN PROVINCE

FINAL REPORT

APPENDIX- B : AGRICULTURE

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APPENDIX B : AGRICULTURE

B.1 INTRODUCTION

B.1.1 Objective of the Study

The main objective of the study is to clarify the present conditions of farming system, such as soil, cropping pattern farming practice, agricultural input materials, and to suggest the reasonable farming plan which is more profitable in the Study Area.

In Nam Dan District, farm size per household is very small (about 0.35 ha) and cropping rate of farm is very high (about 190 %) because present whole agricultural land is very small and there is no space for land reclamation. Therefore, "increase of yield and profit per land" was regarded as a principal viewpoint of the study.

B.1.2 Summary of Field Work

Following data and information were collected.

- Soil classification map and land classification map
- land use condition
- Cropping pattern and crop production
- Farming practice
- Input materials

Collection of the statistics data in the District office and the Provincial office, questionnaire survey on typical farmers, discussion with staff of the District and the Province, observation on crops growing field were carried out.

B.1.3 Summary of Agricultural Development Plan

Based on the results of field survey and analysis of present conditions, the agricultural development plans consisting of Land Use plan, Farming Plan and Production Plan are proposed. In addition, 4 projects were proposed, but these are described in the Appendix D because all projects are concerning agricultural supporting services.

(1) Basic Concepts for Land Use Plan

The agricultural land in the Study Area is categorized into 7 categories and activities for agricultural development of each category were suggested after clarified the regional potential and constrains of respective category.

(2) Basic Concepts for Farming Plan

For the improvement of farming practice in Nam Dan District, the basic considerations consisting of 10 items are applied: Establishment of diversified farm management system, Balanced development of agriculture, forestry and fishery, Improvement of cropping pattern, Effective water use, Introduction of crop varieties

adaptable for environmental condition & Development of farming technology and their extension, Promotion of agricultural mechanization, Promotion of production increase of livestock, fruits and fishes, Promotion of afforestation, Institution and reinforcement of agricultural supporting system for agricultural development, Promotion of group farm management.

(3) Basic Concepts for Production Plan

Based on the basic considerations for farming practices mentioned above, the increase of crop yield and the conversion from Summer rice cropping with lower yield to Summer-Autumn rice cropping with higher yield as possible as admitted of water supply will be promoted. The main cropping patterns for each zone are proposed. In addition, the Crop Production Plan produced by the above mentioned cropping pattern was proposed.

B.2 PRESENT CONDITION OF AGRICULTURE

B.2.1 Soil Classification and Land Classification

(1) Soil Classification

The Study Area for soil classification covers an area of approximately 19,000 ha representing 64.5% of the Nam Dan District. The soils classification does not cover the area of the South Nghe An Province Irrigation Project implemented by the World Bank and the hillside areas. Based on the FAO-UNESCO Soil Map of the World (FAO, 1990) and the Guidelines for Soil Description (FAO, 1990), a soil classification map of the Study Area at an scale of 1/25,000 has been elaborated. Based on the field survey and analysis results, soils of the Study Area can be classified into 5 major soil groups, 10 soil units and 29 soil sub-units (see Table B.2.1). The major soil groups are as follows:

- Fluvisols group (FL) :	3,400 ha	(22.0%)	1 unit	7 sub-units
- Gleysols group (GL) :	2,210 ha	(14.8%)	2 units	7 sub-units
- Acrisols group (AC) :	3,510 ha	(23.6%)	4 units	7 sub-units
- Plinthosols group (PT) :	1,480 ha	(9.9%)	2 units	6 sub-units
- Leptosols group (LP) :	4,290 ha	(28.8%)	1 unit	2 sub-units
Sub-total :	14,890 ha			
Other areas :	4,200 ha			
Total :	19,090 ha			

Fluvisols group occurs mainly at riverside of Lam River in southern communes of the Study Area. This group was formed by the deposits of Lam River alluvium. The acidity is light acidic or neutral. This soil is highly suitable for growth of rice at irrigable areas and upland crops at non-irrigable area.

Gleysols group often occurs neighboring Fluvisols area at the opposite side of the River. This soil is formed from low relief, flat plain, poorly drained field which is usually water saturated for more than 6 months per year using rice double cropping. This soil is suitable to grow rice.

Acrisols group can be found at almost all communes in the Study Area. This soil is suitable for upland crops and annual crops, and some soil units are suitable to grow fruit trees. This soil group is divided into 4 soil units: Gleyic Acrisols is formed on medium relief soil which is used for upland crops and single rice cropping; Ferric Acrisols is formed on gently undulating topography and major land form is upland, well drained, which is used for single rice or upland crops; Haplic Acrisols is formed on below foot of hill, undulating topography, very well drained. This soil is used for upland crops and fruit trees; Ferralic Acrisols is formed on hilly topography or steeply dissected topography of granite, rhyolite rock. This soil disposes at mountainous communes.

Plinthosols group is formed from the old degraded alluvial deposits which have been under dry conditions for a long time; as a consequence, iron oxide is strongly concentrated. This soil group is divided into 2 soil units: Eutric Plinthosols is formed on plat or high relief, well drained, which is suitable for double rice and single upland crops or single rice and single upland crops. Distric Plinthosols is formed on high relief. This soil is suitable to grow upland crops or alternation of crops.

Leptosols group can be found at places with hilly and mountainous topography with a slope of more than 15 degree. There are many rocks found on the surface. This soil is not suitable to grow annual crops but can be used for garden agriculture as fruit trees and forestry.

Outline of soil classification (including the characteristics of each soil unit), area of each soil unit and soil map are shown in Table B.2.2 and Fig. B.2.1, respectively.

(2) Land Classification

Land classification is carried out applying the Guideline for Land Classification of FAO-UNESCO. The results are shown in Fig. B.2.2, Table B.2.3 and B.2.4. The area of each utilization type and suitability class is summarized as follows:

Land Type and Suitability

Utilization Types	Area of each suitability class (ha)				
	S1	S2	S3	N	Total
Land for Rice	867.2	2,399.6	256.3		3,523.1
Land for Rice and Upland Crops		2,257.8	311.3		2,569.1
Land for Upland Crops	659.8	960.6	1,901.8	5,275.6	8,797.8
Total of Land for Classification	1,527.0	5,618.0	2,469.4	5,275.6	14,890.0
Habitation and Special Land				3,071.0	3,071.0
Rivers, Streams, Ponds, Lakes				1,095.0	1,095.0
Total of Natural Area	1,527.0	5,618.0	2,469.4	9,441.6	19,056.0

S1: Highly suitable, S2: Moderately suitable, S3: Marginally suitable, N: Non suitable.

B.2.2 Land Use

The main uses of agricultural land in Nam Dan District are as shown below. Agricultural land, forest land and water surface for aquaculture covered about 11,530 ha, about 4,400 ha and about 200 ha respectively in 1995. These lands occupy about 40 %, 15 % and 0.5 % of total district area, respectively.

Actual Land Use in Nam Dan District (1995)

Category	Area (ha)
Residential	2,300
of which : Garden land	1,450
Agricultural land	11,530
a. Annual crop	11,510
- Single rice crop	2,200
- Double rice crop	4,000
- Double rice crop + single upland crop	1,600
- Single rice crop + single upland crop	660
- Double upland crop + single rice crop	1,050
- upland crop	2,000
b. Perennial crop	20
Forest land	4,400
Water surface for Aquaculture	200
Special using land	3,000
No use land	8,000
Total	29,430

(Source) Calculated from the Land Use Map (1995)

The land of Nam Dan is classified into three categories according to the topography; Hilly land, Middle land and Plain land. Hilly land is located at the northern part and western part along the district border and occupies about 25% of total district area. Although the Hilly land is considered to be suitable for forest, about 40 % of this land is actually bare land. Middle land is situated along Hilly land with a width of 300 to 400 meters. Most of this land is a resident area and the inhabitants use their gardens mainly as orchards and sometimes grow cassava. Other areas are plain lands and mainly used as rice and upland crops fields.

Agricultural land comprises 11,510 ha of annual crops land (including sugar cane and mulberry according to the statistics of Nam Dan District) and 20 ha for perennial crops land. Annual crops land is classified into six categories.

Rice is cultivated on about 80 % of annual crop land. In addition, about 80 % of annual crops land is carried out double (about 50 %) or triple (about 30 %) cropping with rice and/or upland crops. Only less than 20 % is rice single cropping field because of mainly flood.

B.2.3 Agricultural Production

The sown area, production and yield of the main crops in Nam Dan District are as shown below:

Sown Area of Main Crops in Nam Dan District

(ha)

Crop	1992	1993	1994	1995
W-Sp Rice	6,726	6,846	6,877	6,794
Su-Au Rice	5,358	5,399	5,930	5,924
Sum Rice	1,599	1,544	957	839
Rice Total	13,683	13,789	13,764	13,557
Maize	805	1,226	1,450	2,167
Sweet Potato	1,141	857	2,112	2,198
Peanut	1,538	1,613	1,878	2,032
Vegetables	649	755	934	1,127
Sugarcane	168	112	118	202
Cassava	184	117	144	173
Mulberry	162	342	202	205

(Source) People's Committee of Nam Dan

Production of Main Crops in Nam Dan District

(tons)

Crop	1992	1993	1994	1995
W-Sp Rice	25,160	25,559	27,767	29,246
Su-Au Rice	14,136	15,039	18,931	19,410
Sum Rice	2,068	1,475	2,385	1,864
Rice Total	41,364	42,073	49,083	50,520
Maize	746	1,325	3,111	5,117
Sweet Potato	3,840	4,946	12,869	8,675
Peanut	1,238	2,555	1,941	3,234
Vegetables	4,410	5,481	5,654	6,751
Sugarcane	7,301	5,368	6,076	10,594
Cassava	736	700	432	865
Mulberry	679	2,064	1,279	1,358

(Source) People's Committee of Nam Dan

Yield of Main Crops in Nam Dan District

(tons/ha)

Crop	1992	1993	1994	1995
W-Sp Rice	3.74	3.73	4.04	4.30
Su-Au Rice	2.64	2.79	3.19	3.27
Sum Rice	1.29	0.95	2.49	2.22

Rice Total	3.02	3.05	3.57	3.93
Maize	0.93	1.08	2.15	2.36
Sweet Potato	3.37	5.77	6.09	3.95
Peanut	0.80	1.58	1.03	1.59
Vegetables	6.80	7.26	6.05	5.99
Sugarcane	43.46	47.80	51.66	52.45
Cassava	4.00	5.98	3.00	5.00
Mulberry	4.12	5.98	6.39	6.67

(Source) People's Committee of Nam Dan

In addition, sown area, production and yield of rice and other main crops at each cropping season, which are estimated from the results of field survey by the Study Team, are shown in Table B.2.5, B.2.6 and B.2.7 respectively.

Rice is the most important crop and occupies more than 60% of total crop planted area. Production of paddy amounts to 50,520 tons, that is 320 kg per capita. Peanuts, maize and sweet potatoes are planted in more than 2,000 ha each; it is estimated that about twice the amount obtained during 10 years ago. Peanuts is an important cash crop which is sold through intermediate to an agro-export company as a raw material for oil production. Most of maize and sweet potato are used as food stuff for livestock; there is scarcely any grassland in the District. Vegetables such as water spinach, field radish, lettuce, chili, onion etc. are planted covering 1,100 ha. The products are sold at the markets in communes, in Nam Dan town and even in Vinh city through middlemen or by the farmers themselves. Although it was not possible to get statistical data, a lot of fruits such as orange, grapefruit, lemon, persimmon etc. are produced and sold at the markets as vegetables. In addition, a small area, less than 200 ha, of sugarcane, mulberry mainly at riverside are planted, cassava is planted mainly at midlands and soybean or green bean at rice fields. There is scarcely a surplus of major food crops and industrial crops which are expected as cash crops of farmers in Nam Dan District. It is necessary to increase the production of these crops.

B.2.4 Livestock and Aquaculture

The number of main livestock in Nam Dan District is as shown below:

Number of Livestock in Nam Dan District

(head)

Livestock	1992	1993	1994	1995
Buffalo (1)	8,815	8,285	8,839	10,110
Cattle (1)	16,381	18,086	20,890	20,487
Pig (2)	34,396	37,751	39,906	41,945
Poultry (1)			116,100	115,700

(source)

(1) People's Committee of Nam Dan

(2) Statistic Data of Nghe An Province

Buffalo is the major draft animal found in the area and serves for land preparation in both paddy and upland fields. Although some cattle are also used as draft animals(use in upland field is much more than that of paddy field), more cattle are raised for meat. The average number of cattle, pig and poultry per farm household is 0.7, 1.4 and 3.4 heads, respectively. These livestock are major sources of cash income. It is necessary to introduce high productive strains, to improve technology of feeding and management of livestock.

It is said that there are about 200 ha of water surface for aquaculture in Nam Dan district. However, it is estimated that there are actually much more fish ponds. In addition, there are about 500 ha of Lam river and about 100 ha of reservoirs; it seems that potential of inland water fishery in the district is high. There is the Inland Fishery Center, under the Fishery Department of the Nghe An Province, at Nam Giang Commune. Although the Center supplies 60 million of fry per year to the farmers, the demand for fry far exceeds the supply. Inland fishery is also one of the major sources for cash income.

B.2.5 Farming Practices

(1) Cropping System

There are six cropping systems on annual crop land, which are classified into six categories according to the cropping system as mentioned above (see B.2.2 Land Use). The typical rotation model is as shown below. Details of cropping system are shown in Fig. B.2.4.

Present Cropping Systems

Mark	Category	Rotation Model
CP1	Single rice crop	Winter-Spring Rice [W-Sp] or Summer Rice [Su]
CP2	Double rice crop	W-Sp Rice + Summer-Autumn Rice [Su-Au] or W-Sp Rice + Su Rice
CP3	Double rice crop + Single upland crop	W-Sp Rice + Su-Au Rice + Winter Upland Crop (Maize, Sweet Potato or Vegetable) [W U.C]
CP4	Single rice crop + Single upland crop	Su Rice + Spring U.C (Maize or Sweet potato) [Sp U.C] Su Rice + Winter-Spring U.C (Maize or Sweet potato)[W-SpU.C]
CP5	Double upland crop + single rice crop	W-Sp U.C (Maize, Sweet potato or Peanut) + Su-Au Rice + W U.C (Maize, Sweet Potato or Vegetable), W-Sp U.C + Su Rice + W U.C
CP6	Upland crop (Single, Double, Triple)	Spring U.C (Maize, Sweet potato or Peanut) [Sp U.C] + W U.C (Maize, Sweet Potato or Vegetable), Sp U.C + Summer U.C (Soybean or Green Bean) [Su U.C] + W U.C

(2) Rice Cultivation

There are three seasons of rice cropping; winter-spring rice cropping (W-Sp), summer-autumn rice cropping (Su-Au) and summer rice cropping (Su). Paddy yield of W-Sp cropping which is sown from December to January and harvested at May is highest among three cropping, followed by Su-Au cropping which is sown at May

and harvested at September and Su cropping which is sown at July and harvested at November is lowest (see Table B.2.7).

Usually after W-Sp cropping, Su-Au cropping is done. Sometimes Su cropping has to be carried out because of lacking water in the field. If water is available in June, the farmers choose Su-Au cropping. Su cropping may suffer from flooding from middle of the September to the first half of November.

Growing period of rice strictly depends on cropping season. Thus, suitable varieties are limited in each cropping season. Growing period and yield of main varieties are as shown below:

Growing Period and Rice Yield by Variety

Variety	Growing Period (days)			Yield (without (o) and with (w) Irrigation) (t/ha)					
	W-Sp	Su-Au	Su	(o) W - Sp (w)		(o) Su - Au (w)		(o) Su	(w)
IR 1820	170-180			3.5-3.8	4.5-5.0				
IR 17494	160-170			3.2-3.5	4.0-4.5				
CR 203	120-125	110-115		2.5-3.0	3.0-3.5	2.5-2.8	3.0-3.5		
BAO THAI			140-150					1.8-2.0	-

These varieties do not satisfy the farmers' demand. Main demands of the farmers concerning rice varieties are higher yields, disease tolerance and resistance to insects. Farmers want to harvest more than 6 t/ha in W-Sp rice. The tolerance to blast and sheath blight is especially demanded and the resistance to brown planthopper is also requested by farmers.

Rice is generally transplanted after 25 days seeding on nursery bed. However, some varieties need about 50 days of growing period on nursery bed in W-Sp rice because of low temperature. Land preparation of rice field is carried out with local plow and harrow driven by buffalo. This work needs about 20 days per ha (1 day=8 hours). A few farmers have exceptionally a power tiller and they carry out the contracted land preparation for neighboring farmer's fields after completed the work of theirs. Land preparation work for 1 ha of field is completed only 2 days with the power tiller. Service fee for land preparation of 1 ha of field is from 400,000 to 700,000 VND. According to the results of the socio-economic survey about 40 % of answers expressed the need of farm mechanization in order to be free from heavy labor. On the other hand, direct seeding of rice is carried out a little in W-Sp cropping to avoid a heavy labor of rice transplanting. However, direct seeding in summer-autumn cropping is impossible because of shortage of fallow field as a result of intensive land use.

Application amount of fertilizer is generally 150-200 kg/ha of urea, 150-200 kg/ha of superphosphate and 60-80 kg/ha of potassium chloride and 6-7 tons per hectare of manure. Application amount in Nam Dan is less than level of the general standard of Viet Nam(see Table B.2.8).

Major insect pests are Yellow rice borer (*Tryporyza incertulas*), Brown planthopper (*Nilaparvata lugens*) and Leaf fold (*Cnaphalocrosis medinalis*). Padam 95SP and Bassa 40EC etc. are sprayed for insect control by instruction from the Agricultural

Protection Station. Major diseases are Blast (*Pericularia oryzae*) for W-Sp rice and Sheath blight (*Pellicularia sasakii*) for Su-Au rice. Fujione 40EC and Validacin 3A are also sprayed for control of Blast and Sheath blight, respectively by instruction from the same Station. Weeding is carried out generally by manual labor and herbicide such as Sofit 40ND is also applied sometimes (see Table B.2.9).

Rice seed is supplied by cooperatives or private stores. Although some seeds are produced at the limited seed production farmer's fields under contract with the Seed Station located at Hung Tien Commune, quantity of its produced seeds is 40-50 tons in each cropping season and this quantity covers only less than 10 % of total cropping area of Nam Dan District. There were no seed inspection nor certification system in the Nghe An Province to say nothing in Nam Dan District. Fortunately, Nghe An Provincial Seed Test & Inspection Center was established at June 1997 and a seed inspection system is providing.

As a result of studying actual situation of rice cropping during past few years in Nam Dan District, it was estimated the average yield of paddy as shown below:

Estimated Yield of Paddy in Nam Dan

Water condition	Cropping season		
	W._Sp.	Su._Au.	Summer
irrigated	4.32	3.31	
rainfed	2.15		1.30

(Source) JICA Study Team

(3) Upland Crops

Main upland crops grow on rice field with intensive cultivation such as double cropping and triple cropping with rice. On the other hand, intensive rotational cultivation of upland crops are carried out on the land where irrigation is difficult. Cassava is cultivated a little on the middle land. Application amounts of fertilizers for main upland crops are shown below:

Amount of Fertilizer Presently Used in Nam Dan

Crop	Chemical Fertilizer kg/ha			Manure
	Urea	Sup. Phos.	K. Cl.	t/ha
Maize	100 - 120			6 - 8
Sweet potato	40 - 60		50 - 70	6 - 8
Peanut	40 - 60	200 - 300	80 - 100	6 - 8
Green bean	60 - 80			6 - 8
Sesame	70 - 80			6 - 8
Chili	40 - 50	150 - 250	40 - 60	6 - 8
Sugar cane	350 - 450	400 - 600	50 - 70	6 - 8

(Source) JICA Study Team

Application amount in Nam Dan is less than level of the general standard of Viet Nam (see Table B.2.10).

Land preparation is carried out with local plow and harrow driven by buffalo or ox. Most management works are carried out by using manual labor.

As a result of studying actual situation of upland crops cropping during past few years in Nam Dan District, it was estimated the average yield of each crop as shown below:

Estimated Yield of Upland Crops in Nam Dan

Crop	Cropping season		
	W._Sp.	Su._Au.	Winter
Maize	1.80		1.40
Sweet potato	4.50		4.50
Peanut	1.40		
Green bean		0.70	
Sesame		0.60	
Vegetables	6.00	6.00	6.00
Chili	0.80		
Sugar cane			48.00

(Source) JICA Study Team

B.3 FORMULATION OF MASTER PLAN FOR AGRICULTURAL DEVELOPMENT

In consideration of lack of space of farming land which is able to develop, it is necessary to increase yield through introduction of new technology and input of effective materials and to rise cropping rate through intensive cropping in order to increase agricultural production in the District.

B.3.1 Land Use Plan

The agricultural land in the Study Area is categorized into 5 major categories, i.e., hilly zone, middle zone, upland crop zone, rice zone and flood plain zone. In the category of rice zone, the following three sub-categories are defined to identify the agricultural environment:

- Rice Zone Suffering from Water Shortage
- Rice Zone Having Drainage or Inundation Problem
- Rice Zone Suffering from Inundation and Water Shortage

In addition to the above sub-categories, the project area of the South Nghe An Irrigation Project supported by the World Bank is considered as an independent sub-category of the rice zone. It is denominated as Rice Area with the South Nghe An Irrigation Project. The regional potential and constraints of each category are shown below (see Fig. B.3.1 and Fig. B.3.2):

Zone	Category	Potential	Constraints	Suggested Activities for Agricultural Development
1	Hilly Zone	Contribute to preserve the environment as it is or rehabilitate the environment as it should be from the viewpoint of the watershed management and the protection of agricultural land. Can be used for agroforestry type agriculture that is: production forestry , fuel trees and livestock feed production. Some of hilly land has a capability to be developed for tree crops. Land conservation should be considered carefully.	The present condition of hilly land is considered pessimistic in the Study Area. Bare land or land suffering from erosion covers most of the Area while there are not observed primary stand forest. Land sliding is observed in some Hilly Land and it damages agricultural lands. Considering reforestation program, infertile soil on granite sandy stone, which is dominant in the area, restricts forest growth.	The land use of hilly land consists of protection and conservation areas. In the protection area, agricultural activity is prohibited and reforestation shall be promoted. In the conservation area, agricultural activity shall have constraints against full utilization and intensive cultivation.
2	Middle Zone	Land suitable for tree crops and upland crops. This land is to be used for annual crops such as cassava and perennial crops such as orange, lemon, persimmon, banana, etc. In particular, perennial crops will contribute to raise farmers income as they will become effective cash crops. Also, as this type of land has slope unsuitable for cropping, it is expected to be used as grazing lands for livestock.	Middle Land is not suitable for large scale development because it is scattered in the Study Area in small pocket areas. The soil is generally infertile and water sources are limited. Erosion and land sliding are observed in this kind of land and it damages agricultural land in the plain area.	Perennial crops such as orange, lemon, persimmon, etc. shall be maintained as to raise up cash income for those farmers who do not face environmental problems in their areas. The areas suffering from erosion or land sliding shall be classified as conservation areas and must be developed with careful consideration for environmental aspects.
3	Upland Crop Zone	This area is expected to be a cultivation area of upland crops instead of rice because of the disadvantage of water supply and topographic conditions. Vegetables and forage crops are major crops in this area. The cultivation area of vegetables can be expanded by installing appropriate irrigation system. With an adequate irrigation system, quality will be improved and yields will be raised.	To practice intensive cultivation, this area has less fertile soil and water shortage due to lack of irrigation facilities and water resources. The topographic conditions are not suitable for rice crop due to the unevenness of the land and steep slope. Furthermore, damages from erosion are observed in the area.	The area is expected to be an intensive area of upland crops, vegetables and forage crops with development of irrigation where the potential of water resources exist. In the areas which suffer agricultural land erosion, protection against erosion shall be introduced.

Zone	Category	Potential	Constraints	Suggested Activities for Agricultural Development
		Taking into account the regional crop diversification goal, this area plays an important role in agricultural production in the Study Area.		
4	Rice Zone Suffering from Water Shortage	The yield of Summer-Autumn rice is expected to increase significantly by improving water supply conditions during the planting period. Rice production in the area will increase by raising the yield of Summer-Autumn rice. Furthermore, the combined cultivation vegetables or forage crops and rice is possible over the area if water shortage problem is solved.	The area suffers from water shortage in May and June. This area is developed as an intensive rice crop area. The rice production in the area is restricted by water shortage for cultivation of Summer-Autumn rice; consequently the yield of Su-Au rice is low. Irrigation system can be found in the area; however the equipment do not work properly.	The area shall be targeted for intensive and high yield rice production introducing irrigation system improvements and efficient water use. New development of water resources is required wherever the potential exists.
5	Rice Zone Having Drainage or Inundation Problems	This area has a potential to increase production if a drainage system is developed and inundation is mitigated. The development of a drainage system will contribute to improve soil saturation conditions and make it possible to cultivate vegetables or forage crops with rice.	The area suffers from inundation in September and October due to the depressed topographic conditions. This area is developed as an intensive rice crop area; however, the cropping is restricted by inundation problems during the storm season. This causes deterioration of rice yield for the Summer-Autumn rice cropping.	The area shall be aimed for intensive and high yield rice production by developing a drainage system. For the areas where it is difficult to solve inundation problems, the introduction of deep water tolerant varieties of rice shall be studied.
6	Rice Zone Suffering from Inundation and Water Shortage	This area has a well fertile soil and a high potential to produce rice. In this area, it is difficult to solve inundation problems due to the severe degree of inundation. However, efforts to mitigate damages from inundation are essential. Irrigation water supply during the rice planting period will make it possible to shift cropping pattern and to avoid damage from inundation. By irrigation and drainage	The area suffers from water shortage in May and June as much as frequent heavy inundation in September and October. The heavy inundation deteriorates rice production during the summer season and restricts most of the farmers to one rice crop in the Winter-Spring season. On the other hand, there is water shortage in rice planting period of	The area shall be targeted for intensive and high yield rice production by developing a drainage system to mitigate inundation as well improving the irrigation system. Cultivated area of Summer-Autumn rice is expected to be expanded and the production will increase through an irrigation and drainage development.

Zone	Category	Potential	Constraints	Suggested Activities for Agricultural Development
		development, cultivation area will be expanded and rice production will be increased significantly.	Summer-Autumn rice. It compels farmers to give up cultivation of Summer-Autumn rice and to cultivate Summer rice even though it has severe disadvantage in yield.	
7	Flood Plain Zone	The soil of this area is very fertile and suitable for cultivating because of sedimentary materials from the Lam River. Flooding from the Lam River is unavoidable due to topographic condition. Hence, the present land use for water tolerant crops adapted to the area should be continued.	This area is considered as a flood prone area and suffers from frequent direct floods from the Lam River.	This area shall be used as it is, because the protection from river flood in the area is difficult and investment for protection is not considered reasonable from the economic point of view. A careful cropping program concerning flooding conditions with water tolerant crops is necessary to be implemented in this area.
8	Rice Zone with South Nghe An Irrigation Project	This area is the project area of the South Nghe An irrigation Project and the agricultural environment is planned to be improved. When the Project will be completed, this area will become a rice intensive cultivation area with high yield and production.	Most of this zone has the same characteristics of Zone 4 and some parts have same characteristics of Zone 5. Thus, the same constraints for those Zones apply.	It is an intensive rice crop area (Land use is about same to Zone 4, although style of Zone 5 is partially included).

The present land use for each zone is shown as follows:

Zone	Category	Agricultural land			Forest land	Others	Total
		Paddy field	Upland field	Sub Total			
1	Hilly zone	150	130	280	4,840	1,650	6,770
2	Middle zone	200	700	900	390	730	2,020
3	Upland crop zone	800	800	1600	650	810	3,060
4	Rice zone, W.S.	1,500	100	1600	160	1,290	3,050
5	Rice zone, D. or I.	600	50	650	40	360	1,050
6	Rice zone, I & W.S.	1,500	150	1650	100	1,160	2,910
7	Flood plain zone	200	1000	1200	120	3,170	4,490
8	Rice zone, W/B	3,500	150	3650	90	2,340	6,080
Total		8,450	3,080	11,530	6,390	11,510	29,430

Note: Estimated from land use map (1995)
W.S.: suffering from water shortage, D. or I.: having drainage or inundation problems,
I & W.S.: suffering from inundation and water shortage,
W/B: with South Nghe An Irrigation Project

B.3.2 Farming Plan

For the improvement of farming practice in Nam Dan District, the following basic considerations are applied.

Item	Basic Consideration for Improvement of Farming Practices
Establishment of Diversified Farm Management Systems	It is necessary to establish diversified farm management systems which will go along with the improvement of agricultural and social structures and economic system in Nam Dan District and its surrounding regions. The new systems will contribute to the increase of income level and improvement of nutrition of the inhabitants of the area. The new systems would aim to maintain self sufficiency in basic foods by an efficient use of limited land, to increase production of profitable crops, and to establish a balanced development with others aspects like animal husbandry, fruit gardening and aquaculture. Additionally, the development plan should include promotion of agro-industry.
Balanced Development of Agriculture, Forestry and Fishery	Clean and healthy natural environment is a precious resource for mankind. Thus, any rural development which affects adversely the natural environment should not be overlooked. It is necessary to prepare a harmonious development plan for agriculture, forestry and fishery which will contribute to the conservation of natural environment, water resources, land resources and living environment of residents of Nam Dan District.
Improvement of cropping pattern	Maintaining present cropping pattern basically, agricultural production is considered to be increased by introducing new farming technology. The introduction of cash crops with high returns is also considered.
Effective Water Use	Water shortage is one of the most serious limiting factors of crop production. Present irrigation facilities do not fulfill their function well enough and it restricts cropping and decreases yield. Rehabilitation and additional construction of irrigation facilities is indispensable. This will contribute to increase cropping rate as well as yield levels.
Introduction of Crop Varieties Adaptable for Environmental Condition, Development of Farming Technology and Their Extension	One of the major reasons of low yield of crops in Nam Dan District is shortage of good varieties of crops. For example in rice, every farmer demands good varieties with characteristics of high yield, disease tolerance and insect resistance. Selection and introduction of adaptable varieties are necessary. On the other hand, development of farming technology for getting high yield such as fertilizer application and plant protection and extension of their results are also important. Reinforcement of these activities is necessary. Supplying of high quality seeds to the farmers is also very important.
Promotion of Agricultural Mechanization	Land preparation, transplanting, harvesting and weeding are major works in farming practice, and land preparation and transplanting are the hardest works above all. Introducing agricultural machinery will reduce severe work and improve farmers' working conditions. At the same time, agricultural production will increase and be stabilized through planting appropriate varieties in appropriate time, which is achieved by shortening working days for those practices. Furthermore, land resources, which is limited in the Project Area, can be shifted in use from keeping draft animals to raising beef cattle by agricultural mechanization. It will contribute for farm management diversification and increase of farm income. Introduction of mechanized agriculture has also a potential to provide labor force from agricultural sector to industrial sector when the strong demand of labor force from industrial sector is raised in future.
Promotion of Production Increase of Livestock, Fruits and Fishes	Animal products, fruits and fishes are major resources of cash income for the farmers and important resources for human nutrition of residents. Increase of production of feed crops depends mainly on increase of yield. Preparation of supply system of superior calf, piglet and chicken is necessary for animal production. Preparation of supply system of superior seedling is necessary for

Item	Basic Consideration for Improvement of Farming Practices
	orchard. Reinforcement of actual supply activity of fry for aquaculture is also necessary.
Promotion of Afforestation	More than 40% of forest area is bare land which causes flood in the Lam river basin, seasonal water shortage of reservoirs, soil erosion and shortage of firewood for residents. Thus, afforestation in order to develop water resources, to conserve river basin, to conserve sloping land and to produce firewood is an urgent matter. It is necessary to prepare nurseries for that purpose. In addition, acceleration of undergrowth is necessary because undergrowth of forest is the major feed resources for cattle. The potentiality of forest land use as grazing forest should be assessed.
Institution and Reinforcement of Agricultural Supporting Systems for Agricultural Development	In order to carry out effectively the above-mentioned projects, it is necessary to institute and reinforce the supporting systems like extension system of new technology, reinforcement of existing supply systems of high quality materials used for production such as fertilizer and agro-chemicals, seed and fry, reinforcement of existing plant protection system, etc.
Promotion of Group Farm Management	To change the farm management from small scale farming to group farming should be important for establishment of new farm management system corresponding with marketing condition and increasing of farmers' income.

B.3.3 Proposed Production plan

Based on the basic considerations for farming practices mentioned above, the increase of crop yield and the conversion from Summer rice cropping with lower yield to Summer-Autumn rice cropping with higher yield as possible as admitted of water supply will be promoted. The main cropping patterns for each zone are proposed and shown in Table B.3.1 which is summarized as follows:

Proposed Cropping Pattern

Zone	W. - Sp.		Su - Au.		Summer		Winter		Year Total		
	Rice	Upland Crop	Rice	Upland Crop	Rice	Upland Crop	Rice	Upland Crop	Rice	Upland Crop	Total
1	94	178	0	102	114	0	0	100	208	380	588
2	150	730	71	150	50	0	0	411	271	1,291	1,562
3	500	1,100	600	400	200	0	0	700	1,300	2,200	3,500
4	1,150	450	1,200	100	150	0	0	500	2,500	1,050	3,550
5	400	250	400	50	0	0	0	50	800	350	1,150
6	1,250	400	1,200	100	100	0	0	400	2,550	900	3,450
7	150	1,050	150	150	0	0	0	600	300	1,800	2,100
8	3,150	500	3,150	150	0	0	0	400	6,300	1,050	7,350
Total	6,844	4,658	6,771	1,202	614	0	0	3,161	14,229	9,021	23,250

Note: W. - Sp. is from late January to May.
Su. - Au. is from early June to middle September.
Summer is from early July to middle November.
Winter is from late September to middle January.

The proposed crop production produced by the above mentioned cropping pattern is shown in Table B.3.2 and is summarized as follows:

Crop	Cropping Season				Total
	W-Sp	Su-Au	Summer	Winter	(ton)
Rice(Irrigated)	24,346	31,494	0	0	55,840
Rice(Rainfed)	7,285	0	1,044	0	8,329
Sub Total	31,631	31,494	1,044	0	64,169
Maize	2,090	0	0	2,690	4,780
Sweet potato	5,497	0	0	6,367	11,864
Ground nut	3,417	0	0	0	3,417
Green bean*	0	500	0	0	500
Sesame	0	35	0	0	35
Vegetables	1,440	3,830	0	3,462	8,732
Chili	74	0	0	0	74
Sugar cane	12,180	0	0	0	12,180
Mulberry	1,300	0	0	0	1,300

B.3.4 Proposed Agricultural Development Projects

Projects for irrigation and drainage improvement, agricultural supporting, agro-industry and marketing system are proposed for concerning agricultural development. The detail description of those projects are descried in the Appendixes C, D and E.

APPENDIX B : TABLES

Table B.2.1 List of Soil Classification

Soil name	Symbols	Area ha	Area % %	Texture
1. Fluvisols	**FL**	**3,396.0**	**17.8**	
1.Hapli Eutric Fluvisols	FLe-h	299.1	1.6	SL-CL
2.Silti Eutric Fluvisols	FLe-si	336.4	1.8	SiL-SiCL
3.Areni Eutric Fluvisols	FLe-a	1,114.2	5.8	SL-FSL
4.Epi Gleyi Eutric Fluvisols	FLe-g1	821.7	4.3	L
5.Endo Gleyi Eutric Fluvisols	FLe-g2	27.7	0.1	L
6.Epi Hypo Ferri Eutric Fluvisols	FLe-fe4-1	116.9	0.6	SL
7.Abrupti Eutric Fluvisols	FLe-ab	680.0	3.6	CL
2. Gleysols	**GL**	**2,211.0**	**11.6**	
8.Stagni Eutric Gleysols	GLe-st	292.6	1.5	SL
9.Anthraqui Eutric Gleysols	GLe-an	386.8	2.0	CL-SL
10.Stagni Dystric Gleysols	GLd-st	620.4	3.3	SiCL
11.Silti Dystric Gleysols	GLd-si	105.0	0.6	L-SiL
12.Anthraqui Dystric Gleysols	GLd-an	298.0	1.6	CL
13.Epi Hypo Ferri Dystric Gleysols	GLd-fe4-1	364.3	1.9	SL-L
14.Endo Hypo Ferri Dystric Gleysols	GLd-fe4-2	143.9	0.8	SL-L
3. Acrisols	**AC**	**3,513.6**	**18.4**	
15.Epi Hypo Ferri Gleyic Acrisols	ACg-fe4-1	341.0	1.8	SL
16.Endo Hypo Ferri Gleyic Acrisols	ACg-fe4-2	164.7	0.9	SL
17.Endo Hyper Ferri Gleyic Acrisols	ACg-fe5-2	172.8	0.9	SL
18.Areni Ferric Acrisols	ACfe-a	497.8	2.6	FSL-CoSL
19.Areni Haplic Acrisols	ACh-a	35.0	0.2	CoSL
20.Epi Lithi Ferralic Acrisols	ACf-l1	1,370.2	7.2	SL
21.Endo Lithi Ferralic Acrisols	ACf-l2	932.1	4.9	SL
4. Plinthosols	**PT**	**1,478.0**	**7.8**	
22.Epi Gleyi Eutric Plinthosols	PTe-g1	370.0	1.9	SL-FSL
23.Endo Gleyi Eutric Plinthosols	PTe-g2	112.5	0.6	SL-FSL
24.Epi Hyper Ferri Eutric Plinthosols	PTe-fe5-1	192.5	1.0	SL-FSL
25.Endo Gleyi Dystric Plinthosols	PTd-g1	668.5	3.5	SL
26.Endo Gleyi Dystric Plinthosols	PTd-g2	92.0	0.5	SL
27.Areni Gleyi Dystric Plinthosols	PTd-a	42.5	0.2	SL-CoSL
5. Leptosols	**LP**	**4,291.4**	**22.5**	
28.Hyper Ferri Dystric Leptosols	LPd-fe5	164.0	0.9	L
29.Epi Lithi Dystric Leptosols	LPd-l1	4,127.4	21.7	L-CL
Sub Total		1,489.0	78.1	
Habitation & special land		3,071.0	16.1	
Rivers, streams, ponds, lakes		1,095.0	5.7	
Total		19,056.0	100.0	

(Source) NIAPP: Report of soil map and land classification map, 1997

Table B.2.2 Outline of Soil Classification

Soil name	Symbols	Area ha	Area % %	Texture	Soil Color of Sub Surface	Cul.Layer Thickness	Bulk Density	pH H_2O	CEC c mol/kg	BS %	OC %	Av.P_2O_5 mg/100g	Av. K_2O mg/100g
						cm	g/cm3						
1. Fluvisols	**FL**	**3,396.0**	**17.8**										
1.Hapli Eutric Fluvisols	FLe-h	299.1	1.6	SL-CL	2.5YR 5-6/2-4	25	1.0-1.6	6.0-7.0	5.0-10.0	50-80	0.3-1.0	4.0-10.0	4.0-7.0
2.Silti Eutric Fluvisols	FLe-si	336.4	1.8	SiL-SiCL	10YR 4-5/3-6	20	1.2-1.7	6.0-7.0	4.0-10.0	55-70	0.5-1.0	3.0-7.0	4.0-8.0
3.Areni Eutric Fluvisols	FLe-a	1,114.2	5.8	SL-FSL	2.5YR 5-6/2-3	30	1.2-1.8	6.0-7.0	4.0-10.0	60-85	0.3-0.6	4.0-8.0	3.0-8.0
4.Epi Glevi Eutric Fluvisols	FLe-g1	821.7	4.3	L	7.5YR 6-7/2	18	1.2-1.8	6.0-7.0	4.0-8.0	55-80	0.6-1.2	5.0-10.0	4.0-8.0
5.Endo Glevi Eutric Fluvisols	FLe-g2	27.7	0.1	L	7.5YR 6-7/2	18	1.2-1.8	6.0-7.0	4.0-8.0	55-80	0.6-1.2	5.0-10.0	4.0-8.0
6.Epi Hypo Ferri Eutric Fluvisols	FLe-fe4-1	116.9	0.6	SL	10YR 4-6/2-4	17	1.0-1.6	5.8-7.2	5.0-10.0	55-75	0.5-1.2	5.0-12.0	5.0-9.0
7.Abrupti Eutric Fluvisols	FLe-ab	680.0	3.6	CL	10YR 5-6/3	20	1.0-1.7	6.0-7.0	4.0-8.0	50-70	0.4-1.0	5.0-10.0	3.0-7.0
2. Gleysols	**GL**	**2,211.0**	**11.6**										
8.Stagni Eutric Gleysols	GLe-st	292.6	1.5	SL	7.5Y 4-6/2-3	20	1.0-1.2	5.0-7.0	4.5-8.0	55-85	0.7-1.4	4.0-10.0	3.0-7.0
9.Anthraqui Eutric Gleysols	GLe-an	386.8	2.0	CL-SL	7.5YR 5-6/2-3	18	1.0-1.2	6.0-7.2	5.0-10.0	55-80	0.6-1.2	4.0-10.0	3.0-7.0
10.Stagni Dystric Gleysols	GLd-st	620.4	3.3	SiCL	7.5Y 4-6/1-2	18	1.4-2.0	4.5-6.0	6.0-10.0	20-50	0.8-1.4	4.0-8.0	2.0-7.0
11.Silti Dystric Gleysols	GLd-si	105.0	0.6	L-SiL	7.5YR 4-5/4								
12.Anthraqui Dystric Gleysols	GLd-an	298.0	1.6	CL	10YR 5/3-4	18	1.2-1.8	4.5-6.0	7.0-10.0	less 50	0.8-1.4	4.0-10.0	4.0-7.0
13.Epi Hypo Ferri Dystric Gleysols	GLd-fe4-1	364.3	1.9	SL-L	10YR 6/2	14	1.0-1.5	5.0-6.0	5.0-8.0	20-40	0.6-1.0	5.0-9.0	3.0-6.0
14.Endo Hypo Ferri Dystric Gleysols	GLd-fe4-2	143.9	0.8	SL-L	10YR 6/2								
3. Acrisols	**AC**	**3,513.6**	**18.4**										
15.Epi Hypo Ferri Gleyic Acrisols	ACg-fe4-1	341.0	1.8	SL	10YR 6-7/4	20	1.0-1.5	5.0-6.0	4.0-8.0	20-45	0.8-1.1	4.0-8.0	3.0-7.0
16.Endo Hypo Ferri Gleyic Acrisols	ACg-fe4-2	164.7	0.9	SL	10YR 6-7/4								
17.Endo Hyper Ferri Gleyic Acrisols	ACg-fe5-2	172.8	0.9	SL	10YR 6-7/4								
18.Areni Ferric Acrisols	ACfe-a	497.8	2.6	FSL-CoSL	10YR 5/4	16	1.0-1.4	5.0-6.0	3.0-5.0	less 50	less 0.8	very poor	very poor
19.Areni Haplic Acrisols	ACh-a	35.0	0.2	CoSL	10YR 6/3	17	1.0-1.6	5.5-6.5	5.0-8.0	less 40	very poor	very poor	very poor
20.Epi Lithi Ferralic Acrisols	ACf-l1	1,370.2	7.2	SL	5YR 5-6/3-4	15	1.4-1.8	4.5-6.0	5.0-10.0	less 30	1.0-1.8	1.5-3.0	2.5-5.0
21.Endo Lithi Ferralic Acrisols	ACf-l2	932.1	4.9	SL	5YR 5-6/3-4								
4. Plinthosols	**PT**	**1,478.0**	**7.8**										
22.Epi Glevi Eutric Plinthosols	PTe-g1	370.0	1.9	SL-FSL	7.5YR 5-6/2	18	1.0-1.4	5.0-6.0	4.0-6.0	more 50	less 1.0	5.0-10.0	4.0-8.0
23.Endo Glevi Eutric Plinthosols	PTe-g2	112.5	0.6	SL-FSL	7.5YR 5-6/2								
24.Epi Hyper Ferri Eutric Plinthosols	PTe-fe5-1	192.5	1.0	SL-FSL	10YR 6/2-3								
25.Endo Glevi Dystric Plinthosols	PTd-g1	668.5	3.5	SL	10YR 5/2-3	14	1.4-2.0	4.5-6.0	5.0-10.0	less 40	less 1.0	4.0-6.0	5.0-8.0
26.Endo Glevi Dystric Plinthosols	PTd-g2	92.0	0.5	SL	10YR 5/2-3								
27.Areni Glevi Dystric Plinthosols	PTd-a	42.5	0.2	SL-CoSL	10YR 6/2-3	18	0.8-1.4		6.0-10.0	less 40	less 0.8	4.0-8.0	less 10.0
5. Leptosols	**LP**	**4,291.4**	**22.5**										
28.Hyper Ferri Dystric Leptosols	LPd-fe5	164.0	0.9	L		13			4.0-6.0	less 40	more 1.0	4.0-8.0	3.0-6.0
29.Epi Lithi Dystric Leptosols	LPd-l1	4,127.4	21.7	L-CL									

BS: Base saturation, OC: Organic Carbon, Av.: Available

Table B.2.3 Relationship of Soil Type and Land Use Ability

Types of soil	Area (ha)	Area % (%)	Suitability and Ability				
			Rice		Upland Crop (annual crop)	Fruit tree	Forestry
			Irrigation	No Irrig.			
Fluvisols (FL)	3,396.0	17.8	Suitable		Suitable		
Gleysols (GL)	2,211.0	11.6	Suitable				
Acrisols (AC)	3,513.6	18.4			Ability		
Plinthosols (PT)	1,478.0	7.8			Ability		
Leptosols (LP)	4,291.4	22.5	No Abil.	No Abil.	No Ability	Ability	Ability

(Source) NIAPP: Report of soil map and land classification map, 1997

Table B.2.4 Area of Land Classification for Main Land Use Types

Utilization Types	Whole Area	Percent	S1	S2							
				i	f	t	n	g	sl	d	Sub Total
Land for Rice	3,523.1	18.5	867.2	1,537.1	862.5						2,399.6
Land for Rice & UC	2,569.1	13.5		2,126.5	40.0	60.0		10.0		21.3	2,257.8
Land for UC	8,797.8	46.2	659.8	54.0	716.3	4.7	137.8	12.0	22.7	13.1	960.6
Sub Total	14,890.0	78.2	1,527.0	3,717.6	1,618.8	64.7	137.8	22.0	22.7	34.4	5,618.0
Habit. & Special	3,071.0	16.1									
Water Surface	1,095.0	5.7									
Total	19,056.0	100.0	1,527.0	3,717.6	1,618.8	64.7	137.8	22.0	22.7	34.4	5,618.0

Utilization Types	S3						N			
	i	f	t	sl	d	Sub Total	sl	g	d	Sub Total
Land for Rice	12.8	197.1			46.4	256.3				
Land for Rice & UC	218.5		42.5		50.3	311.3				
Land for UC		719.1	3.0	537.1	642.6	1,901.8	3,956.4	14.0	1,305.2	5,275.6
Sub Total	231.3	916.2	45.5	537.1	739.3	2,469.4	3,956.4	14.0	1,305.2	5,275.6
Habit. & Special										
Water Surface										
Total	231.3	916.2	45.5	537.1	739.3	2,469.4	3,956.4	14.0	1,305.2	5,275.6

UC: Upland Crops, Habit. & Special: Habitation and Special Land,
Water Surface: Rivers, Streams, Ponds, Lakes
S1: Highly suitable, S2: Moderately suitable, S3: Marginally suitable, N: Not suitable
i: irrigation, f: flood, t: soil texture, n: nutrient, g: type of soil, sl: slope, d: depth of soil horizon
(Source) NIAPP: Report of soil map and land classification map, 1997

Table B.2.5 Cropping Area of Main Crops in Nam Dan District

(ha)

Crop	Cropping Season				Total
	W-Sp	Su-Au	Summer	Winter	
Rice (Irrigated)	3,299	5,924			9,223
Rice (Rainfed)	3,495		839		4,334
Sub Total	6,794	5,924	839		13,557
Maize	980			1,187	2,167
Sweet potato	1,018			1,179	2,197
Peanut	2,040				2,040
Green bean*		630			630
Sesame		50			50
Vegetables	200	532		460	1,192
Chili	60				60
Sugar cane	210				210
Mulberry	200				200
Total	11,502	7,136	839	2,826	22,303

Note:

W. - Sp. is from late January to May. Su. - Au. is from early June to middle September.
Summer is from early July to middle November. Winter is from late September to middle January.
Green bean is including green bean and soybean.
Sugar cane and mulberry are year-round crops, but they are placed in W.-Sp. colum for calculation.

(Source) JICA Study Team

Table B.2.6 Production of Main Crops in Nam Dan District

(ton)

Crop	Cropping Season				Total
	W-Sp	Su-Au	Summer	Winter	
Rice (Irrigated)	14,245	19,609			33,854
Rice (Rainfed)	7,529		1,091		8,620
Sub Total	21,774	19,609	1,091		42,474
Maize	1,764			1,662	3,426
Sweet potato	4,581			5,306	9,887
Peanut	2,856				2,856
Green bean*		441			441
Sesame		30			30
Vegetables	1,200	3,192		2,760	7,152
Chili	48				48
Sugar cane	10,080				10,080
Mulberry	1,180				1,180

(Source) JICA Study Team

Table B.2.7 Yield of Main Crops in Nam Dan District

(ton/ha)

Crop	Cropping Season				Average
	W-Sp	Su-Au	Summer	Winter	
Rice (Irrigated)	4.32	3.31			3.67
Rice (Rainfed)	2.15		1.30		1.99
Maize	1.80			1.40	1.58
Sweet potato	4.50			4.50	4.50
Peanut	1.40				1.40
Green bean*		0.70			0.70
Sesame		0.60			0.60
Vegetables	6.00	6.00		6.00	6.00
Chili	0.80				0.80
Sugar cane	48.00				48.00
Mulberry	5.90				5.90

(Source) JICA Study Team

Table B.2.8 Recommendatory Fertilizer Application Amount for Rice

(kg/ha)

Season	Urea	Sup.Phos	K. Cl	manure
W_Sp	230	425	110	12,000
Su_Au	200	300	100	10,000
Su	140	200	80	7,000

Note: Recommendation from The National Center of Variety Examination

Table B.2.9 Application Amount of Agricultural Chemicals for Rice

Cropping Season	Insecticide		Fungicide		Herbicide
	Padam 95 SP	Bassa 40 EC	Fujione 40 EC	Validacin 3A	Sofit 40 NĐ
W_Sp Rice	1.4 kg	2.0 litre	2.0 litre		1.0 litre
Su_Au Rice	1.4 kg	1.0 litre		2.0 litre	1.0 litre
Su Rice	1.4 kg				1.0 litre

(Source) People's Committee of Nghe An Province

Note: Padam 95 SP : For Yellow rice borer (*Tryporyza incertulas*)
Bassa 40 EC : For Brown planthopper (*Nilaparvata lugens*)
Fujione 40 EC : For Blast (*Pericularia oryzaea*)
Validacin 3A : For Sheath blight (*Pellicularia sasakii*)

Table B.2.10 Recommendatory Fertilizer Application Amount for Upland Crops

(kg/ha)

Crop	Urea	Sup.Phos	K. Cl	Manure
Maize	280	450	130	15,000
Sweet Potato	180	350	90	10,000
Peanut	60	330	60	10,000
Sesame				10,000
Green bean	180	250	0	10,000
Sugarcane	350	500	300	10,000

Note: Recommendation from The National Center of Variety Examination

Table B.3.1 Sown Area of Crops in Each Category of Land Use

Zone	Rice		Upland Crops										Sub Total	Total
	Season	Area	Season	Maize	Sweet potato	Ground nut	Green bean	Sesame	Vegetables	Chili	Sugar cane	Mulberry		
1	W. Sp.	94	W. Sp.	80	98								178	272
	Su. Au.		Su. Au.				50	10	42				102	102
	Summer	114											0	114
			Winter	50	50								100	100
	Sub Total	208	Sub Total	130	148	0	50	10	42		0	0	380	588
2	W. Sp.	150	W. Sp.	370	360								730	880
	Su. Au.	71	Su. Au.				70	20	60				150	221
	Summer	50												50
			Winter	252	159								411	411
	Sub Total	271	Sub Total	622	519	0	70	20	60		0	0	1,291	1,562
3	W. Sp.	500	W. Sp.	190	250	600			60				1,100	1,600
	Su. Au.	600	Su. Au.				200	20	180				400	1,000
	Summer	200												200
			Winter	300	270				130				700	700
	Sub Total	1,300	Sub Total	490	520	600	200	20	370		0	0	2,200	3,500
4	W. Sp.	1,150	W. Sp.	60	60	270			60				450	1,600
	Su. Au.	1,200	Su. Au.				50		50				100	1,300
	Summer	150												150
			Winter	200	200				100				500	500
	Sub Total	2,500	Sub Total	260	260	270	50	0	210		0	0	1,050	3,550
5	W. Sp.	400	W. Sp.	20	30	200							250	650
	Su. Au.	400	Su. Au.				50						50	450
	Summer													0
			Winter	50									50	50
	Sub Total	800	Sub Total	70	30	200	50	0	0		0	0	350	1,150
6	W. Sp.	1,250	W. Sp.			350				50			400	1,650
	Su. Au.	1,200	Su. Au.				100						100	1,300
	Summer	100												100
			Winter	200	150				50				400	400
	Sub Total	2,550	Sub Total	200	150	350	100	0	50	50	0	0	900	3,450
7	W. Sp.	150	W. Sp.	130	120	290			80	20	210	200	1,050	1,200
	Su. Au.	150	Su. Au.				50		100				150	300
	Summer													0
			Winter	250	250				100				600	600
	Sub Total	300	Sub Total	380	370	290	50	0	280	20	210	200	1,800	2,100
8	W. Sp.	3,150	W. Sp.	100	100	300							500	3,650
	Su. Au.	3,150	Su. Au.				50		100				150	3,300
	Summer													0
			Winter	200	100				100				400	400
	Sub Total	6,300	Sub Total	300	200	300	50	0	200		0	0	1,050	7,350
Total	W. Sp.	6,844	W. Sp.	950	1,018	2,010	0	0	200	70	210	200	4,658	11,502
	Su. Au.	6,771	Su. Au.	0	0	0	620	50	532	0	0	0	1,202	7,973
	Summer	614		0	0	0	0	0	0	0	0	0	0	614
			Winter	1,502	1,179	0	0	0	480	0	0	0	3,161	3,161
	Total	14,229	Total	2,452	2,197	2,010	620	50	1,212	70	210	200	9,021	23,250

Note:

W. - Sp. is from late January to May.

Su. - Au. is from early June to middle September.

Summer is from early July to middle November.

Winter is from late September to middle January.

Green bean of this table includes green bean and soybean.

Table B.3.2 Production Plan of Main Crops

(1) Rice (Unit : Area is ha, Yield is ton/ha, Production is ton)

Season	Proposed Production Plan			Present			Increased Product	
	Area	Yield	Product	Area	Yield	Product	Value	%
W._Sp.(irrigated)	4,146	5.82	24,346	3,299	4.32	14,245	10,101	1.71
W._Sp.(rainfed)	2,698	3.80	7,285	3,495	2.15	7,529	-244	0.97
Sub Total	6,844	5.02	31,631	6,794	3.20	21,774	9,857	1.45
Su._Au (irrigated)	6,771	4.90	31,494	5,924	3.31	19,609	11,885	1.61
Summer (rainfed)	614	1.99	1,044	839	1.30	1,091	-47	0.96
Total	14,229	4.83	64,169	13,557	3.13	42,474	21,695	1.51

(2) Upland Crops (Unit : Area is ha, Yield is ton/ha, Production is ton)

Crop	Season	Proposed Production Plan			Present			Increased Product	
		Area	Yield	Product	Area	Yield	Product	Value	%
Maize	W._Sp.	950	2.20	2,090	980	1.80	1,764	326	
	Su._Au.	0		0	0		0		
	Winter	1,502	1.79	2,690	1,187	1.40	1,662	1,028	
	Total	2,452		4,780	2,167		3,426	1,354	1.40
Sweet potato	W._Sp.	1,018	5.40	5,497	1,018	4.50	4,581	916	
	Su._Au.	0		0	0		0	0	
	Winter	1,179	5.40	6,367	1,179	4.50	5,306	1,061	
	Total	2,197		11,864	2,197		9,887	1,977	1.20
Groundnut	W._Sp.	2,010	1.70	3,417	2,040	1.40	2,856	561	
	Su._Au.			0	0		0	0	
	Winter			0	0		0	0	
	Total	2,010		3,417	2,040		2,856	561	1.20
Green bean & Soybean	W._Sp.	0		0	0		0	0	
	Su._Au.	620	0.81	500	630	0.70	441	59	
	Winter	0		0	0		0	0	
	Total	620		500	630		441	59	1.13
Sesame	W._Sp.	0		0	0		0	0	
	Su._Au.	50	0.70	35	50	0.60	30	5	
	Winter	0		0	0		0	0	
	Total	50		35	50		30	5	1.17
Vegetables	W._Sp.	200	7.20	1,440	200	6.00	1,200	240	
	Su._Au.	532	7.20	3,830	532	6.00	3,192	638	
	Winter	480	7.21	3,462	460	6.00	2,760	702	
	Total	1,212		8,732	1,192		7,152	1,580	1.22
Chili	W._Sp.	70	1.06	74	60	0.80	48	26	
	Su._Au.	0		0	0		0	0	
	Winter	0		0	0		0	0	
	Total	70		74	60		48	26	1.54
Sugar cane	W._Sp.	210	58.00	12,180	210	48.00	10,080	0	
	Su._Au.	0		0	0		0	0	
	Winter	0		0	0		0	0	
	Total	210		12,180	210		10,080	2,100	1.21
Mulberry	W._Sp.	200	6.50	1,300	200	5.90	1,180	120	
	Su._Au.	0		0	0		0	0	
	Winter	0		0	0		0	0	
	Total	200		1,300	200		1,180	120	1.10

Note:

W. - Sp. is from late January to May.

Su. - Au. is from early June to middle September.

Summer is from early July to middle November.

Winter is from late September to middle January.

APPENDIX B : FIGURES

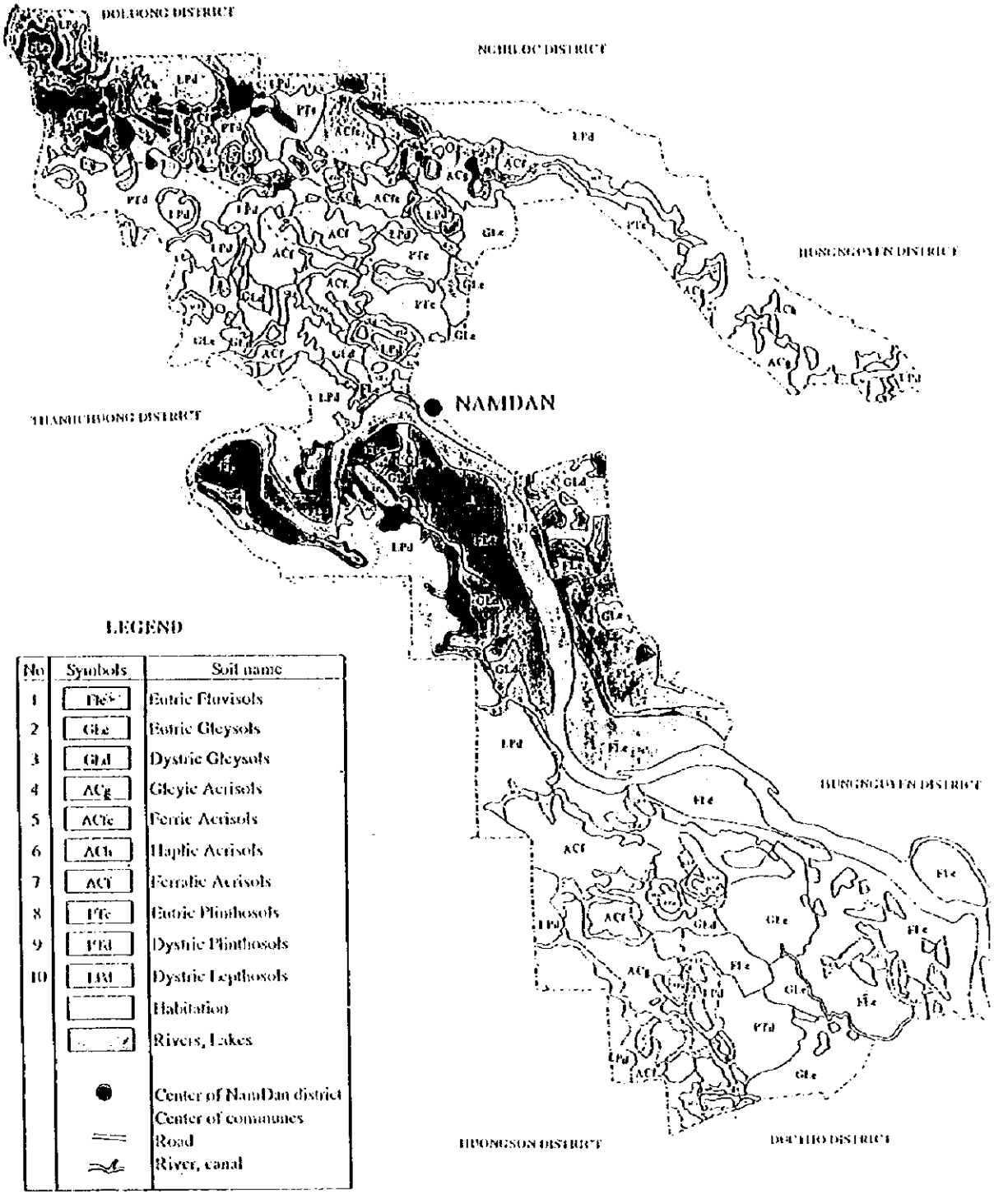

Fig. B.2.1 Soil Map

NAMDAN PROJECT AREA-NGHEAN PROVINCE

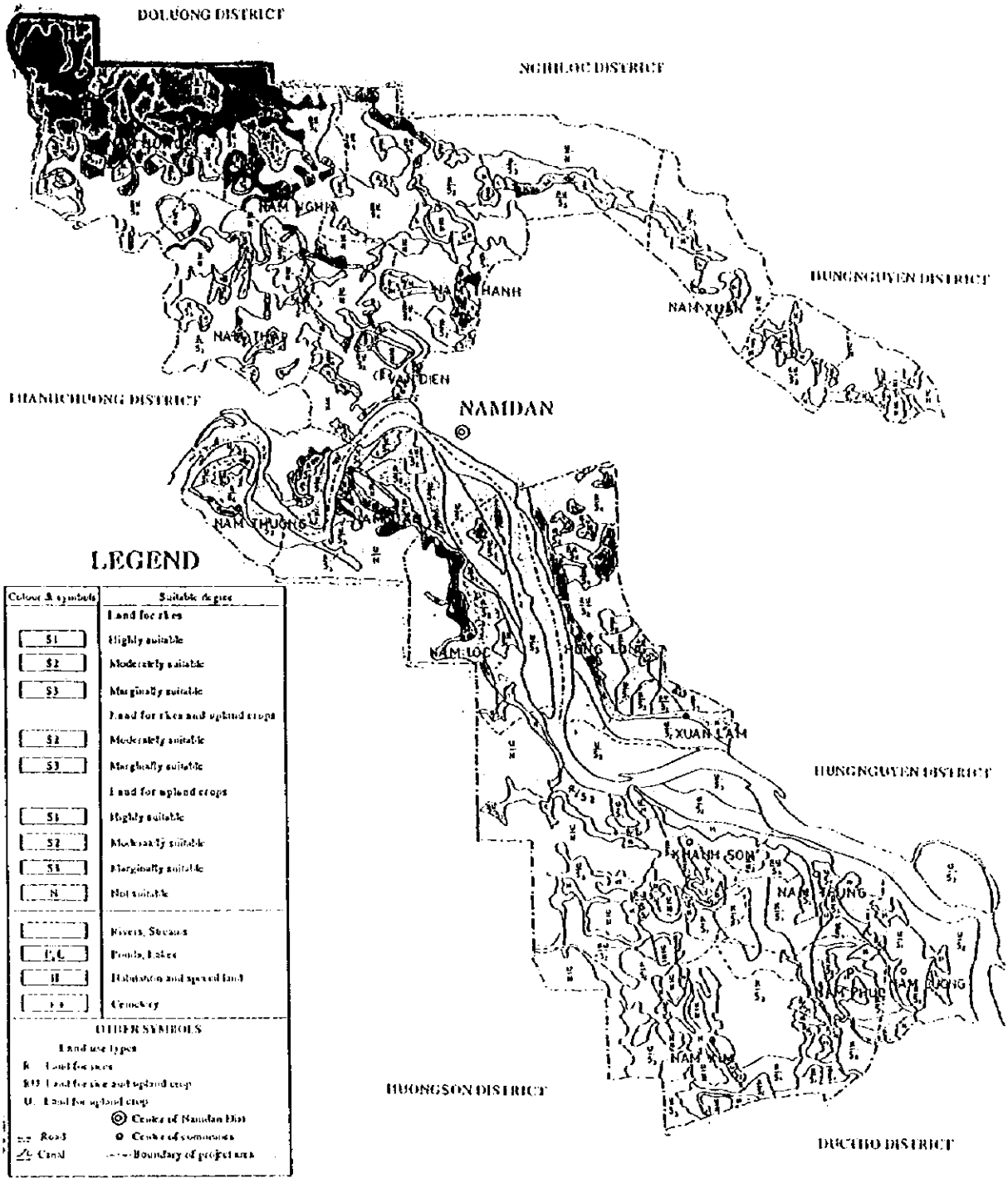

Fig. B.2.2 Land Classification Map
NAMDAN PROJECT AREA - NGHEAN PROVINCE

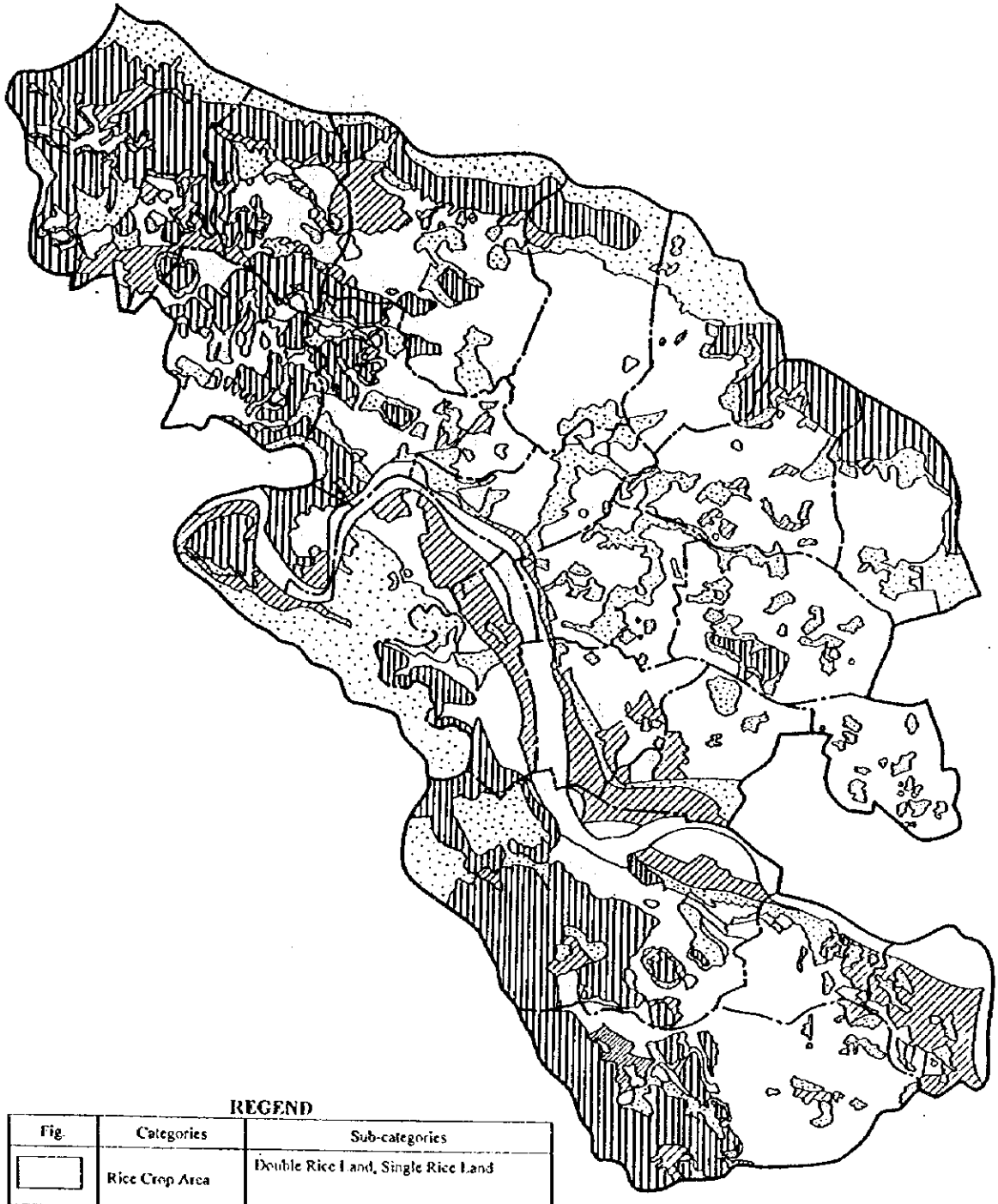

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Fig.	Categories	Sub-categories
	Rice Crop Area	Double Rice Land, Single Rice Land
	Upland Crop Area	Seeding Land, Upland and Industrial Crop Land, Other Annual Crop Land, Fruit Tree Land
	Forest Area	Planting Forest, Protection Forest, Special Forest
	Other Area	Water Surface for Aquaculture, Reservoir, Land for Special Use, Residential Land, Unused Land, Others

Fig. B.2.3 Present Land Use Condition

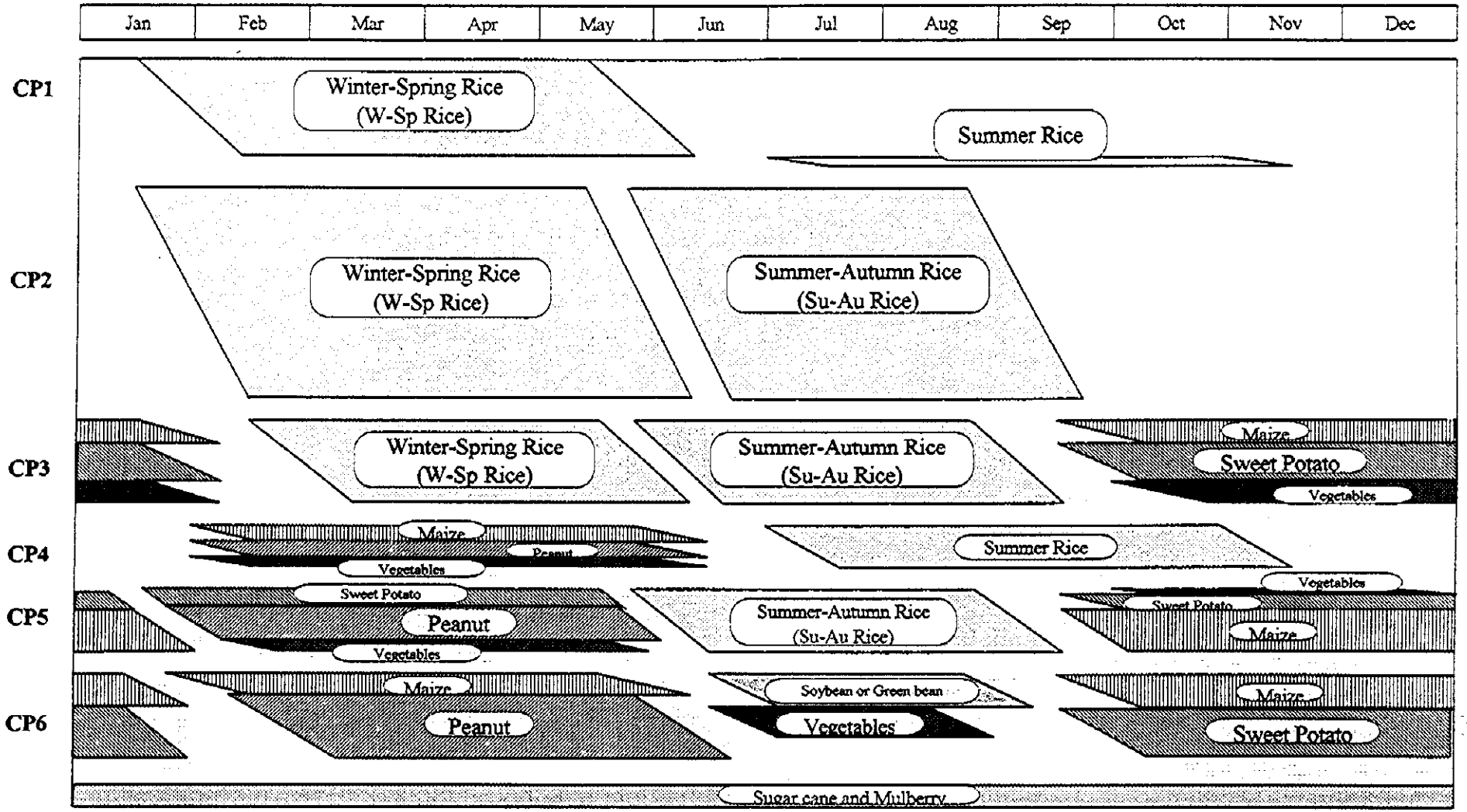
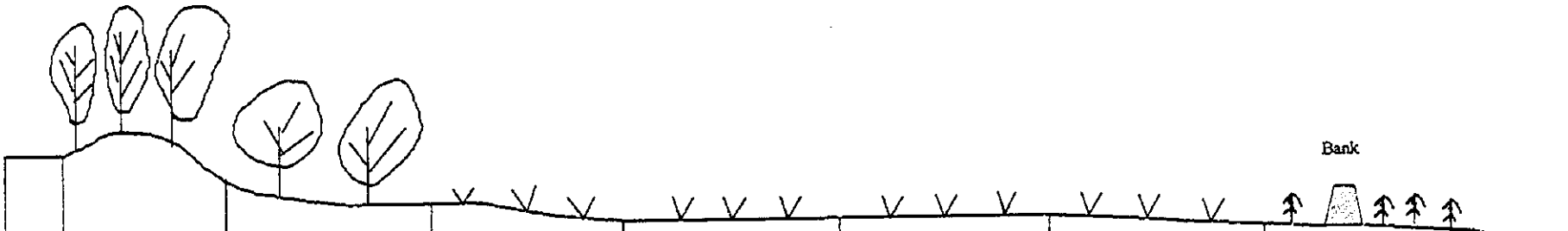


Fig. B.2.4 Present Cropping Patterns in Nam Dan District



Zone	No. 1 **Hilly Zone**	No.2 **Middle Zone**	No.3 **Upland Crop Zone**	No.4 **Rice Zone** **(Suffering from Water Shortage)**	No.5 **Rice Zone** **(Drainage Problems or Suffer. Inundation)**	No.6 **Rice Zone** **(Suffer. from Inundation & Water Shortage)**	No.7 **Flood Plain Zone**	River
Crops	- Forest - No use land	- Annual Crop : Cassava - Perennial crop : Orange, Lemon, Persimmon, Banana, Pineapple, etc.	- Upland Crop - Sp-U.C + Su Rice - Double U.C+ Rice	- Double Rice + U.C. (W-Sp.Rice + Su-Au Rice+W-U.C) If not enough water - Double Rice (W-Sp Rice +Su-Au Rice)	- Double Rice + U.C. (W-Sp Rice + Su-Au Rice+W-U.C)	- Double Rice (W-Sp Rice + Su-Au Rice) Propose: Convert from Su Rice to Su-Au Rice by irrigation facility construction	- Upland Crop Maize, Beans, Peanut, Sweet potato, Vegetables, Sugarcane, Mulberry etc.	
Soil	- Leptosols (mainly Dystric Leptosols) loam - clay loam rocky (infertile soil)	- Acrisols (mainly Ferralic Acrisols) sandy loam (infertile soil)	- Plinthosols (mainly Eutric PT & Dystric PT) sandy loam (less fertile soil)	- Eutric Fluvisols sandy loam - clay loam - Eutric Gleysols clay loam - sandy loam (fertile soil)	- Gleysols (mainly Eutric GL & Distric GL) clay loam - sandy loam (fertile soil)	- Eutric Fluvisols sandy loam - clay loam - Eutric Gleysols clay loam - sandy loam (fertile soil)	- Eutric Fluvisols sandy loam - clay loam (fertile soil)	
Environ.	- Bare land - Erosion - Land sliding	- Erosion - Land sliding	- Water shortage - Erosion	- Water shortage in May and June	- Inundation in Sept. and Oct.	- Water shortage in May and June - Inundation of rice field in Sept. and Oct.	- Inundation sometimes	

Fig. B.3.1 Basic Concept of Agricultural Land Use Plan

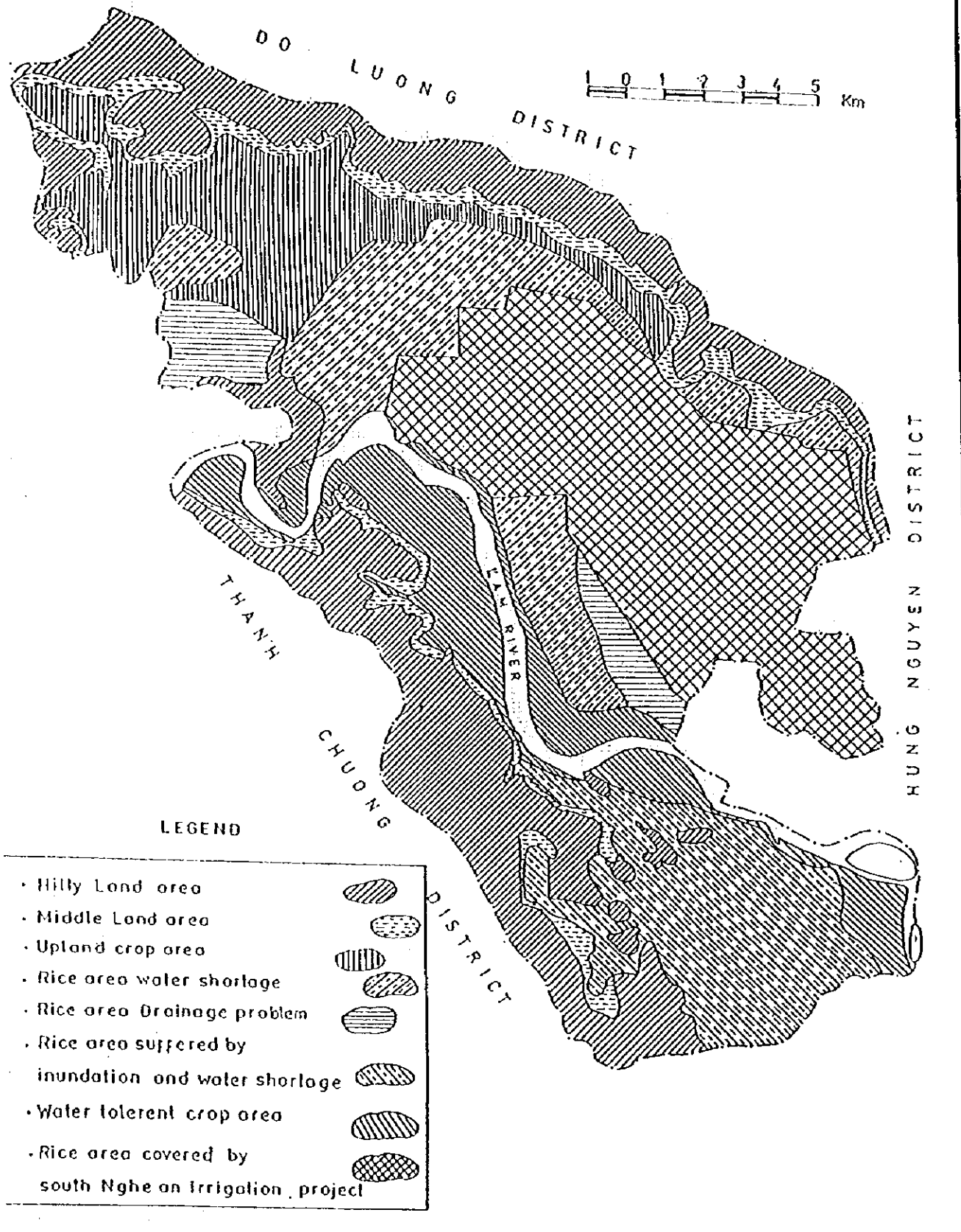


Fig. B.3.2 Proposed Zoning Map