Table 5

Standing Water Bodies in the NW Region

Standing Water Bodies of the NW Region by Planning Units

PLANNING UNIT 1

Name of Standing Water Bodies	Area in Ha
DAULAT PARA	1
MALIGAON	27
BANYA PARA	16
SOMAPOTA	11
DHAP	10
RUHEA	10
PAMULI	4
MALKADAH	11
ALIYAR KHAN	18
MAULANI BIL	10
RAIPUR-HARGUN	22
LALBIL	30
?	5
KASIPUR	23
CHAURAL	23
KHIRAI CHANDI	107
JABARIPUR	4
SALDUB BIL	9
NAPPUR-ALIPUR-SIBPUR	42

PLANNING UNIT 2

Name of Standing Water Bodies	Area in Ha
MALKADAH	11
KIRTANIA PARA	3
CORGRAN-CHURABIL	10
CHAURA BIL	40
HALBARI BIL	16
SATHAGAR	50
CAIDPUR	13
SHIBPUR	249
CHAK SUDAM-NARAYANPUR	107
TANTIPUKUR-SINGANAGAR	17
HAZRATPUR	57
CHANDIPUR-DEBIPUR	53
PALASHDANGI	23
NARAYANPUR-HINGAR BIL	23
HINGAR BIL	19
TAKIPUR-BENUPUR	168
BHABANIPUR	16

Standing Water Bodies of the NW Region by Planning Units

PLANNING UNIT 3

Name of Standing Water Bodies	Area in Ha
CHATNAL	16
TENLAL BIL	57
GABRAL BIL	64
GEGRA-BINBINA	32
PURBA KACHUA	30
GANGACHARA-KHALEA BIL	29
KAUNIA	47
CHAKCHAKA BIL-MOLLA BIL	50
KAUNIA	10
JHIONA BIL-HARDANGA BIL	16
SILIMPUR-DARSANA BIL	19
KISMAT PARUL-SALLAR BIL	43
CHALUNIA BIL-KALSOHAR BIL	15
KOIKURI-KMARPARA	109

PLANNING UNIT 4

Name of Standing Water Bodies	Area in Ha
AMJHOP	15
DIGHAL BARI	50
KALIKAPUR-GOPAL ROY	30
KARNAPUR	94
BAJDAHA-BAIDAPARA	7

PLANNING UNIT 5

Name of Standing Water Bodies	Area in Ha
DIADANGO	26
GATUR KHUTI-SANKOSH	159
AJMATA & MADAIKAI BIL	183
BANGANGA-KANCHAN BIL	700
KARNAPUR	94
NAGDAHA-BALIRAM	67
MADAIKAI & KANCHAN BIL	165
SARAJA BIL-KALISHA ALPARA	111
KACHI CHARER CHARA-KADAMTALA	145
PAULAR BIL-JALANAGAR KUTI	53
SUKDEB-PAULA BIL	263
HOKADANGA-JIGABARI	80

Standing Water Bodies of the NW Region by Planning Units

PLANNING UNIT 6

Name of Standing Water Bodies	Area in Ha
CHATNAL	16
TENLAL BIL	57
DALBARI BIL	13
SHIMUL BARI	6
MAHESPUR	39
PUTIMARI-KISHOREGANJ	39
MAJHPARA	36
SHERPUR	7
ISWARPUR-BHABANIGANJ	90
RAMPUR	13
SILIMPUR-DARSANA BIL	19
KISMAT PARUL-SALLAR BIL	43
KALUPARA-GOPALIPUR	29
JARULYAPUR-DEBHUR-CHAITRAKOL BIL	232
CHALUNIA BIL-KALSOHAR BIL	15
JARULYAUR	7
MADHYAPARA	120
JIBANPUR-SHERUNDANGA BIL	46
KOIKURI-KMARPARA	109
BHAGABATIPUR-AHMEDPUR	113
JAYIUR-RAHIMPUR-AZAMPUR	50
KASIPUR	67
MALDANGA-NURPUR	12
PIRGANJ-JOYPUR	289
NURPUR-ISLAMPUR	85
KRISNAPUR	20
NARAYANPUR	6
SHYAMPUR-KALUGARI-AKIUNAGAR	130
KALASANA	57
PATUA-DURAMARI	123
DARGAPUR-PATUA	50
SOMAIDANGA-PHULCHARI	303
MARIAPARA-MATIJHEEL BIL	45

PLANNING UNIT 7

Name of Standing Water Bodies	Area in Ha
JHIONA BIL-HARDANGA BIL	16
HOKADANGA-JIGABARI	80
CHALUNIA BIL-KALSOHAR BIL	15
KOIKURI-KMARPARA	109
GHARGHARIA	7
MALDANGA-NURPUR	12
NARAYANPUR	6

Standing Water Bodies of the NW Region by Planning Units

PLANNING UNIT 8

Name of Standing Water Bodies	Area in Ha
KALASANA	57
SOMAIDANGA-PHULCHARI	303
MARIAPARA-MATIJHEEL BIL	45
KAMALPUR-MOHAMMADPUR	258
HATGARI	90
TEPAGAR-BARALI BIL	136
HATGARI	90
RUHEAR BIL-MALIANER PARA	405
PALASHBARI-BIL NURAI	547
MADARIPARA-SARIA KANDI	257
AYNSRPARA-DURGAHATA	238
BIL NURAI-MAZBARI	532
QUTUBPUR-GOBINDAPUR	212
NARILA	19
GOBINDAPUR-RATANKANDI	32
BIRGAON-HALDIBARI	90
BIRGAON-HALDIBARI	90
KANGANTI-CHAR BETGAR	31
SIRAJGANJ	18
KUMAJPUR	18

PLANNING UNIT 9

Name of Standing Water Bodies	Area in Ha
PACHBIBI	11
SHYAMPUR-KALUGARI-AKIUNAGAR	130
CHECHURIA	5
BHAT UKA BIL	40
TELIHAR-GORNA	25
MARIAPARA-MATIJHEEL BIL	45
HATGARI	90
SADBILA BIL-DILALPUR	89
BAYRA	15
BAZARPUR-JAGANNATHPUR	25
ICHHAPUR-MOHADEBPUR	181
TEPAGAR-BARALI BIL	136
JUSTAR-BIL-THENGA PARA	105
BIJOYPUR	3
PALASHBARI-BIL NURAI	547
GANGJOAR-BIL PALSA	481
ULKHAR	5
NALARA BIL	28

Standing Water Bodies of the NW Region by Planning Units

PLANNING UNIT 10

Name of Standing Water Bodies	Area in Ha
ISLAMPUR-JABAI BIL	1037
SADBILA BIL-DILALPUR	89
ICHHAPUR-MOHADEBPUR	181
DOBAIL-TILBARI BIL	1314
CHHAT CHANDOS	1118
MAKIMPUR	502
EKLASPUR-HAZHAGI BIL	1372
DARGAPARA-FULBAN	4678
CHAITANPUR	364

PLANNING UNIT 11

Name of Standing Water Bodies	Area in Ha
CHITRA BIL-DARBARPUR	1383
MAKIMPUR	502
EKLASPUR-HAZHAGI BIL	1372
RAJNAGAR	104
DHOLNAGAR-RB MAHANANDA	554
TARAPUR	111
MAHARAJNAGAR-BASUDEBPUR	506
PANKA	51
CHAR NARENDRAPUR	50

PLANNING UNIT 12

Name of Standing Water Bodies	Area in Ha
ULKHAR	5
BALAYAPUR-TAWAL BIL	75
GANGJOAR-BIL PALSA	481
NALARA BIL	28
PARDA BIL	693
AYNSRPARA-DURGAHATA	238
FATEHPUR-MASHAL BIL	735
NAYDAKHOLA BIL-MASHAL BIL	346
GOAL BARI-BAGHMARA	54
NAGAR	3
DHARMAPUR-SAIDPUR	124
ATARI-SHIKARPUR	59
HARIPUR	56
BARAGAON	16
SINGRA-CHALAN BIL	26

Standing Water Bodies of the NW Region by Planning Units

PLANNING UNIT 13

Name of Standing Water Bodies	Area in Ha
CHHAT CHANDOS	1118
DARGAPARA-FULBAN	4678
NAYDAKHOLA BIL-MASHAL BIL	346
NAYDAKHOLA BIL-MASHAL BIL	346
CHAK MANIK-HASANPUR	1790
GOAL BARI-BAGHMARA	54
MOGRAR BIL-QUTUBPUR	682
ATARI-SHIKARPUR	59
MASIABARI-MIRZAPUR	24
GUR-KALIGANJ	84
KISARPUR-NOAPARA	29
MADHABPUR-BATUPARA	23
SINGRA-CHALAN BIL	26
DURGAPUR	107
SIBPUR	5
MANDA KUJA-NAZIRPUR	121
HARIAN	13
DURGAPUR	37
MANAIR-CHATMOHAR	433
SRIRAMPUR-DARIKHAIR	376
AMARPUR	117
AMARPUR	27
LALPUR	43
ISHWARDI	276
DADPUR	164

PLANNING UNIT 14

Name of Standing Water Bodies	Area in Ha
SHERPUR	23
BIRGAON-HALDIBARI	90
DESIGRAM-RUAPARA	142
DESIGRAM-MADHUPUR	30
KUMAJPUR	18
SIRAJGANJ	18
MANAIR-CHATMOHAR	433
JAMTOLI-DAULATPUR	194
CHAIRA-SHYAMPUR	144
JAMTOIL	94
HATGRAM-RATANPUR	103
GOBINDAPUR-SAIDPUR	510

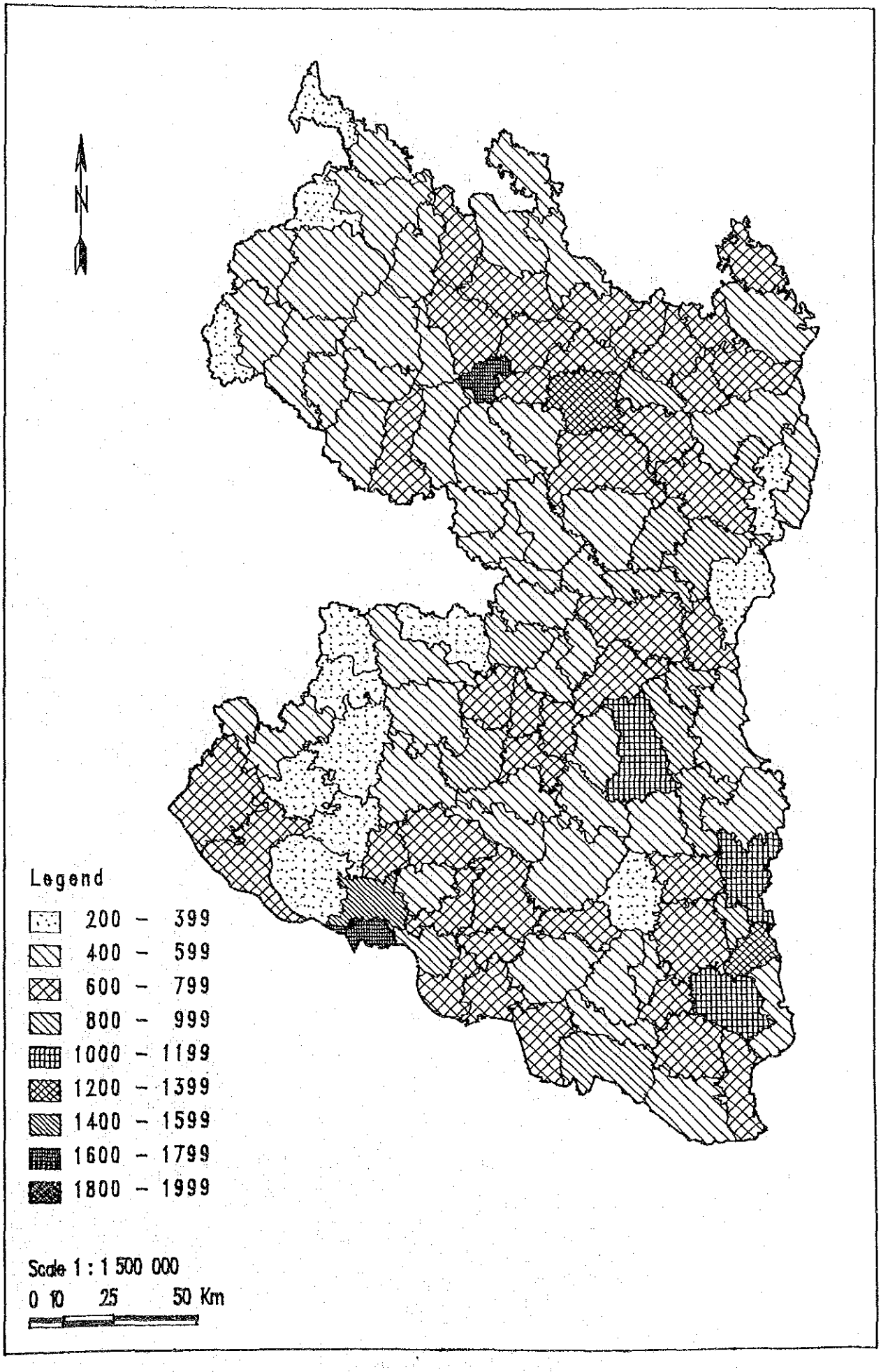
Standing Water Bodies of the NW Region by Planning Units

PLANNING UNIT 15

Name of Standing Water Bodies	Area in Ha
SRIRAMPUR-DARIKHAIR	376
MANAIR-CHATMOHAR	433
CHATMOHAR-LAKSMIPUR	434
HATGRAM-RATANPUR	103
GOBINDAPUR-SAIDPUR	510
HARIA-PAIKARHATI	913
DADPUR	323
ISHWARDI	276
RAHIMPUR-SADULLAPUR	342
GOBINDAPUR-SAIDPUR	510
CHAR HAPANIA-BANGAON	36
HATUABARI-KHETUPARA	248
TALIMNAGAR	80

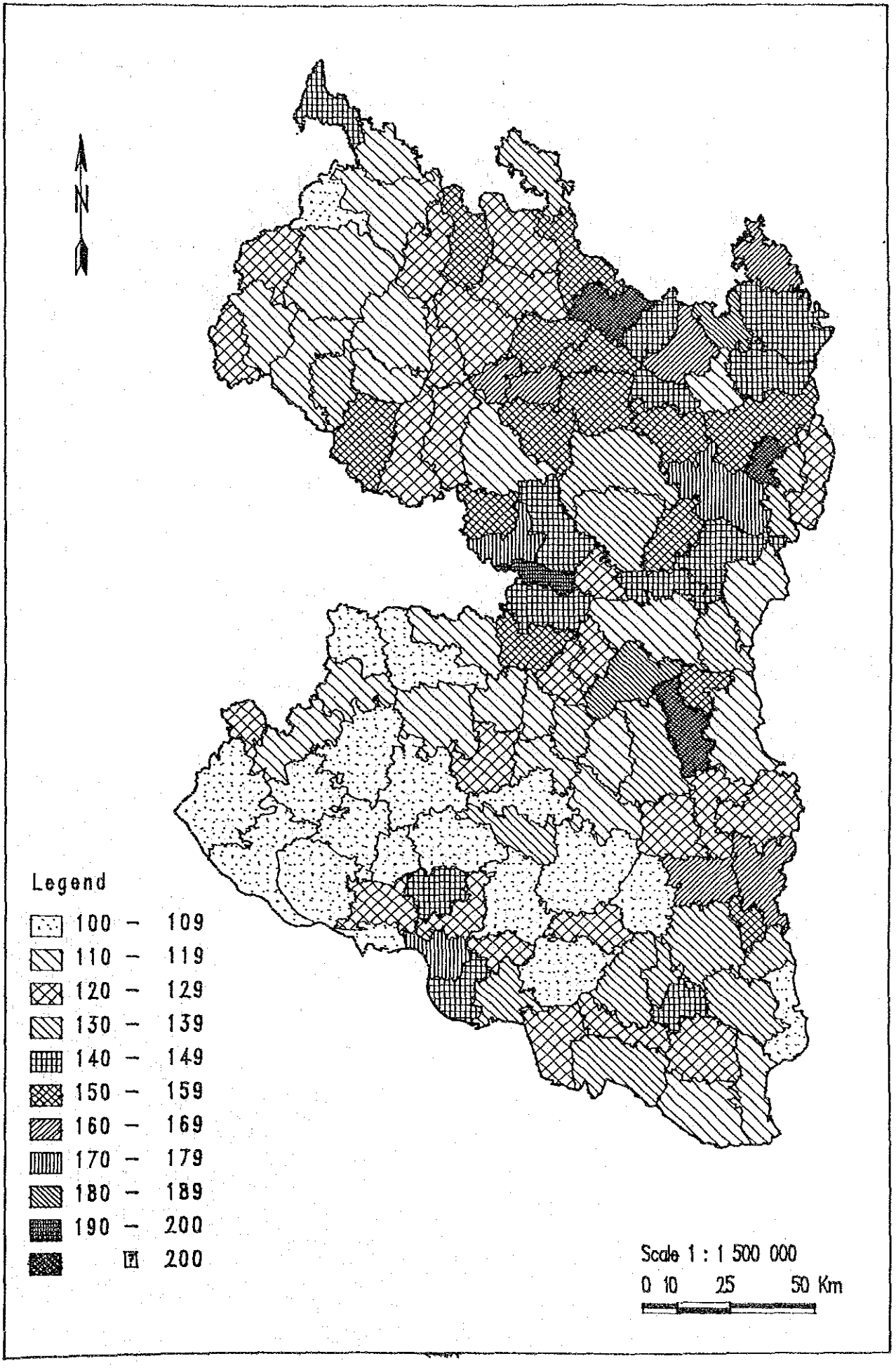
Map 1

Population Density 1981



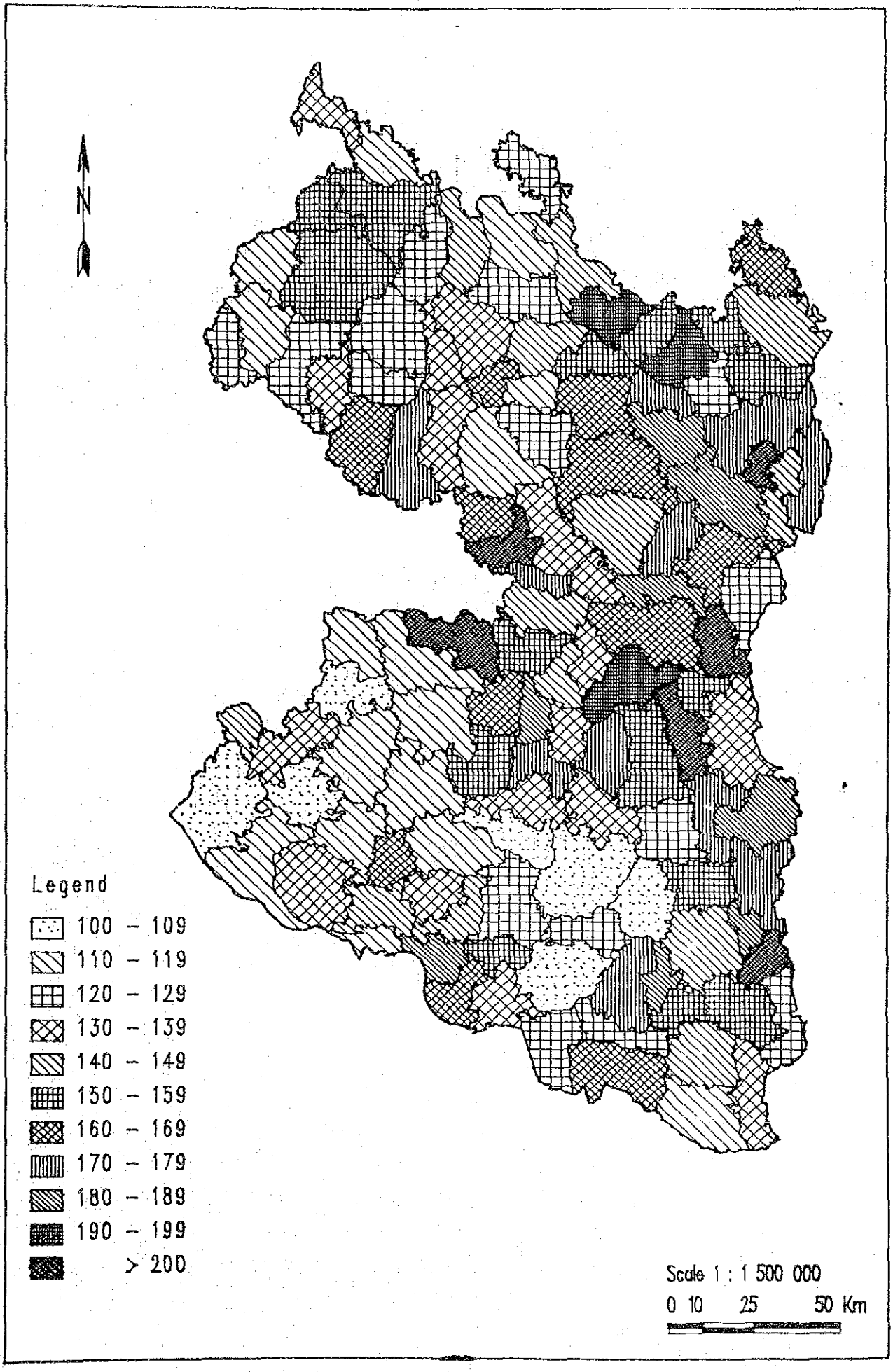
Map 2

Crop Intensity 1980



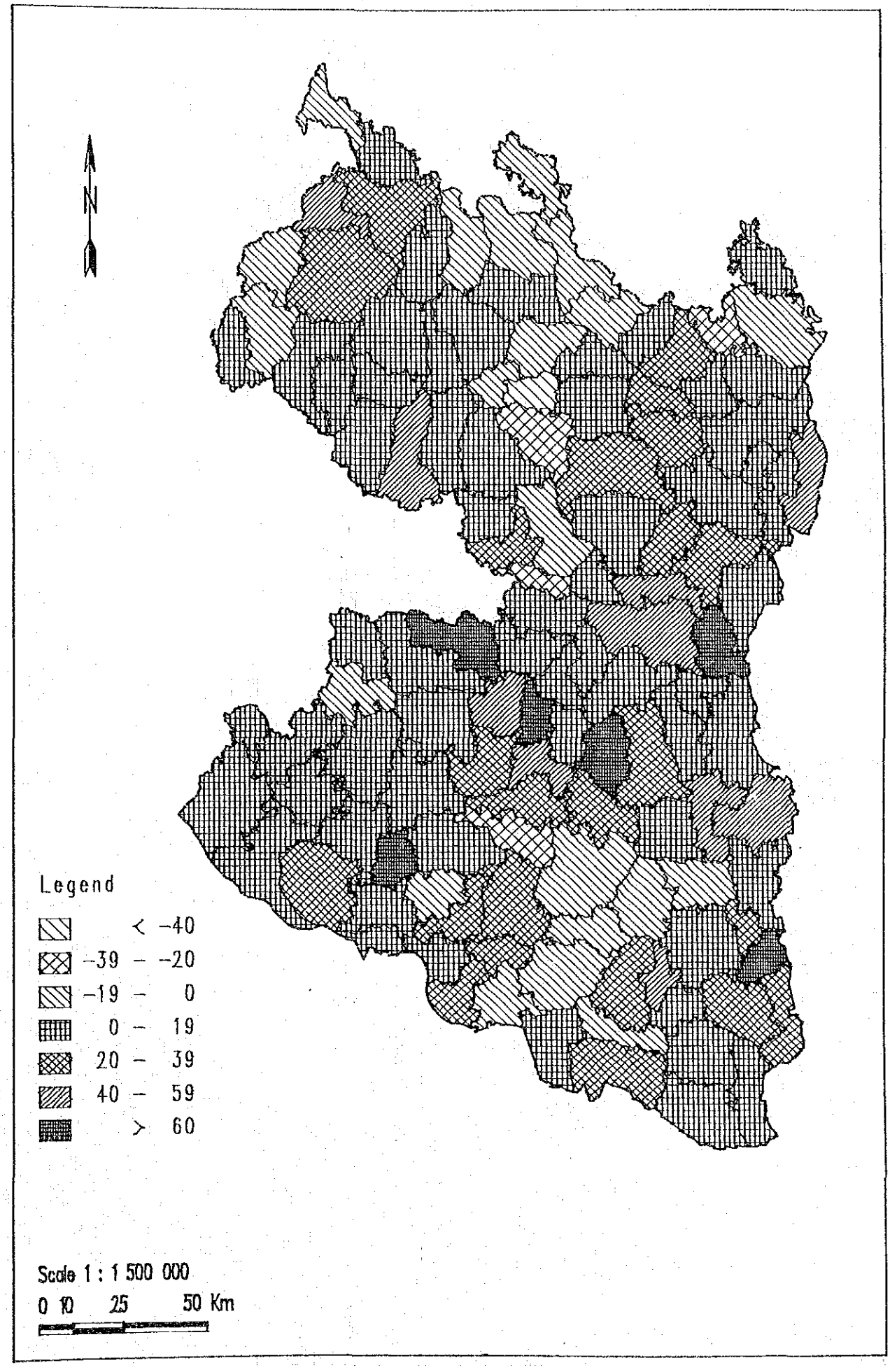
Map 3

Crop Intensity 1987



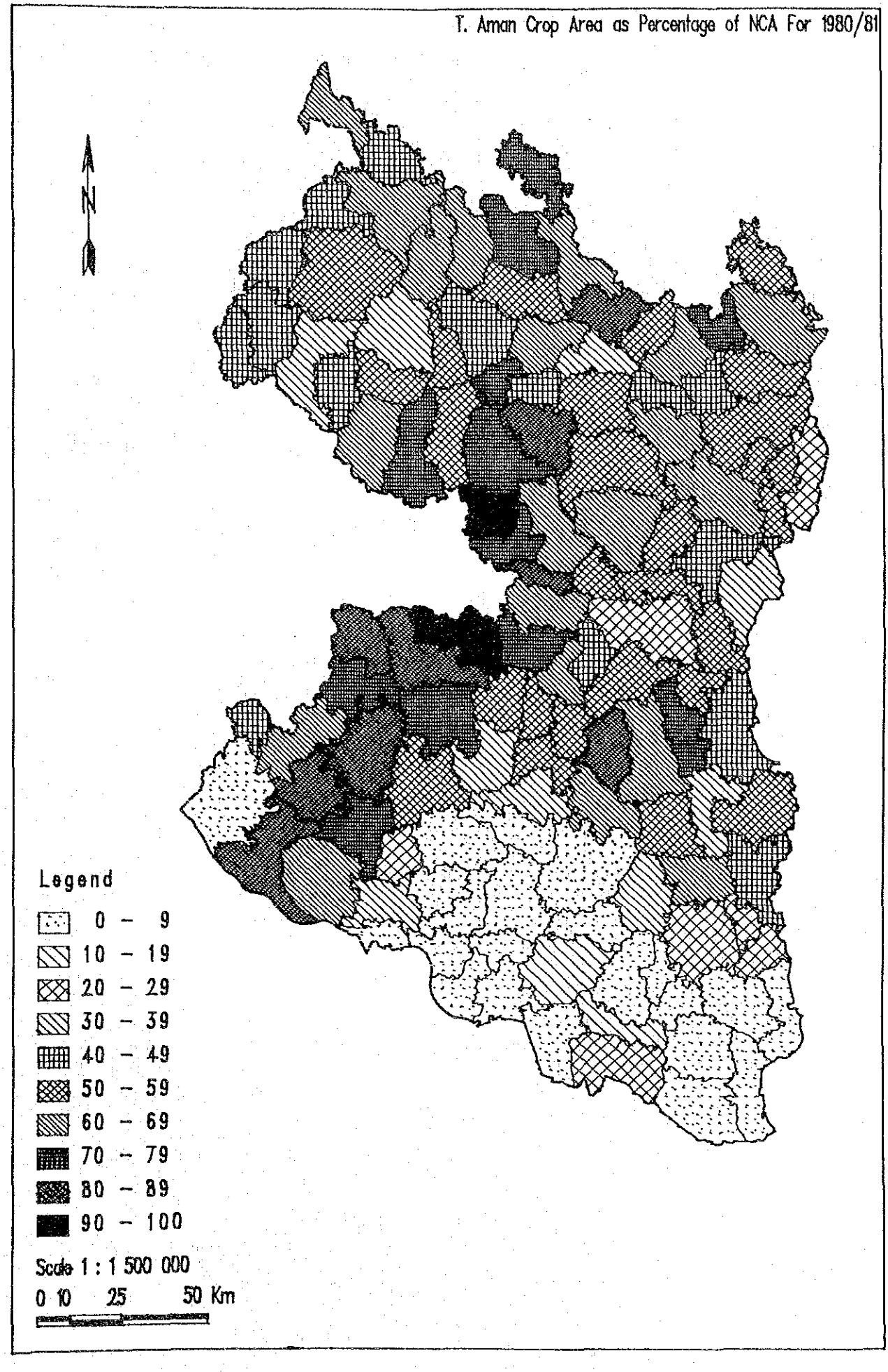
Map 4

Change in Cropping Intensity, 1980-87



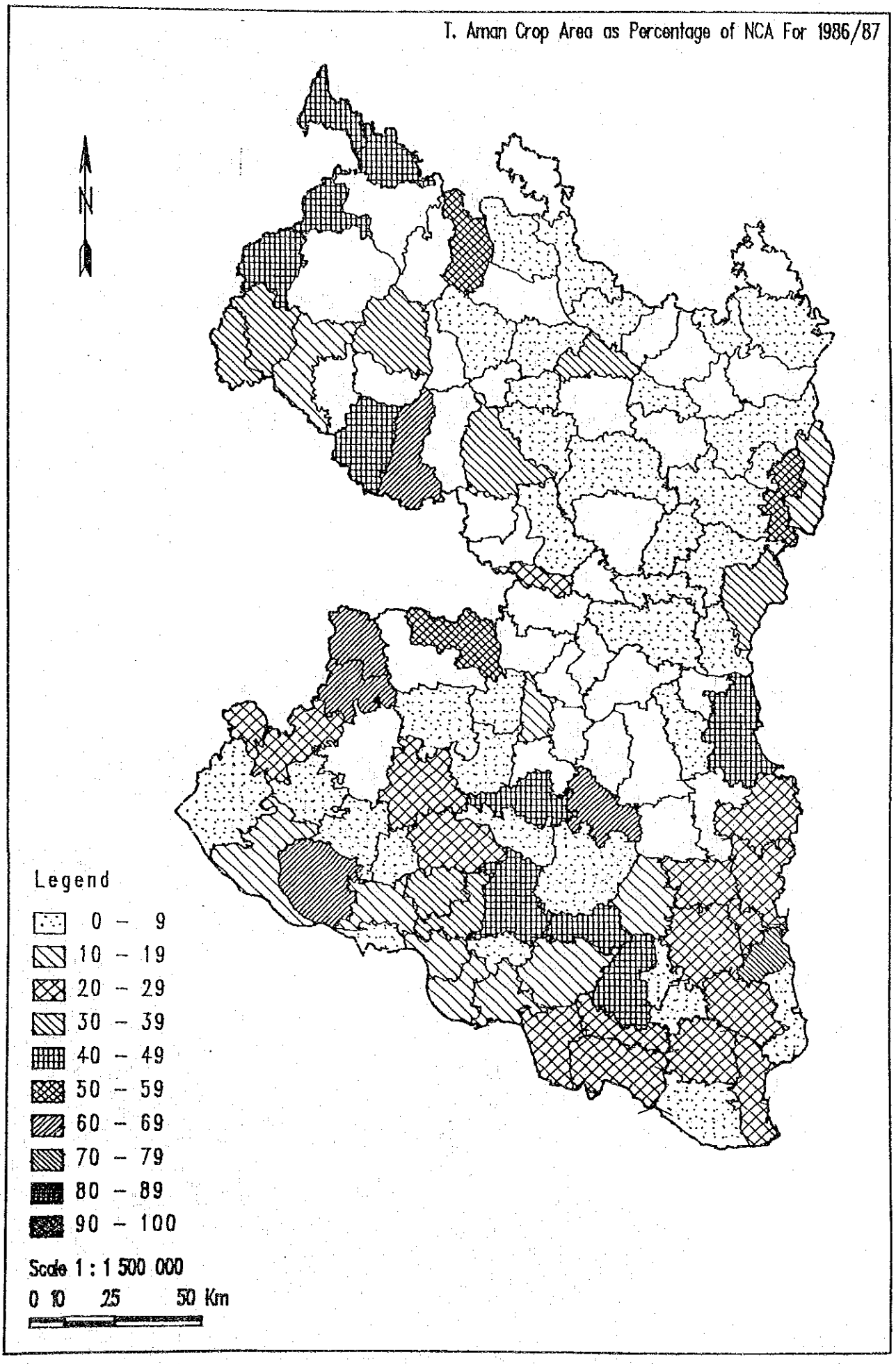
Map 5

Transplanted Aman 1980



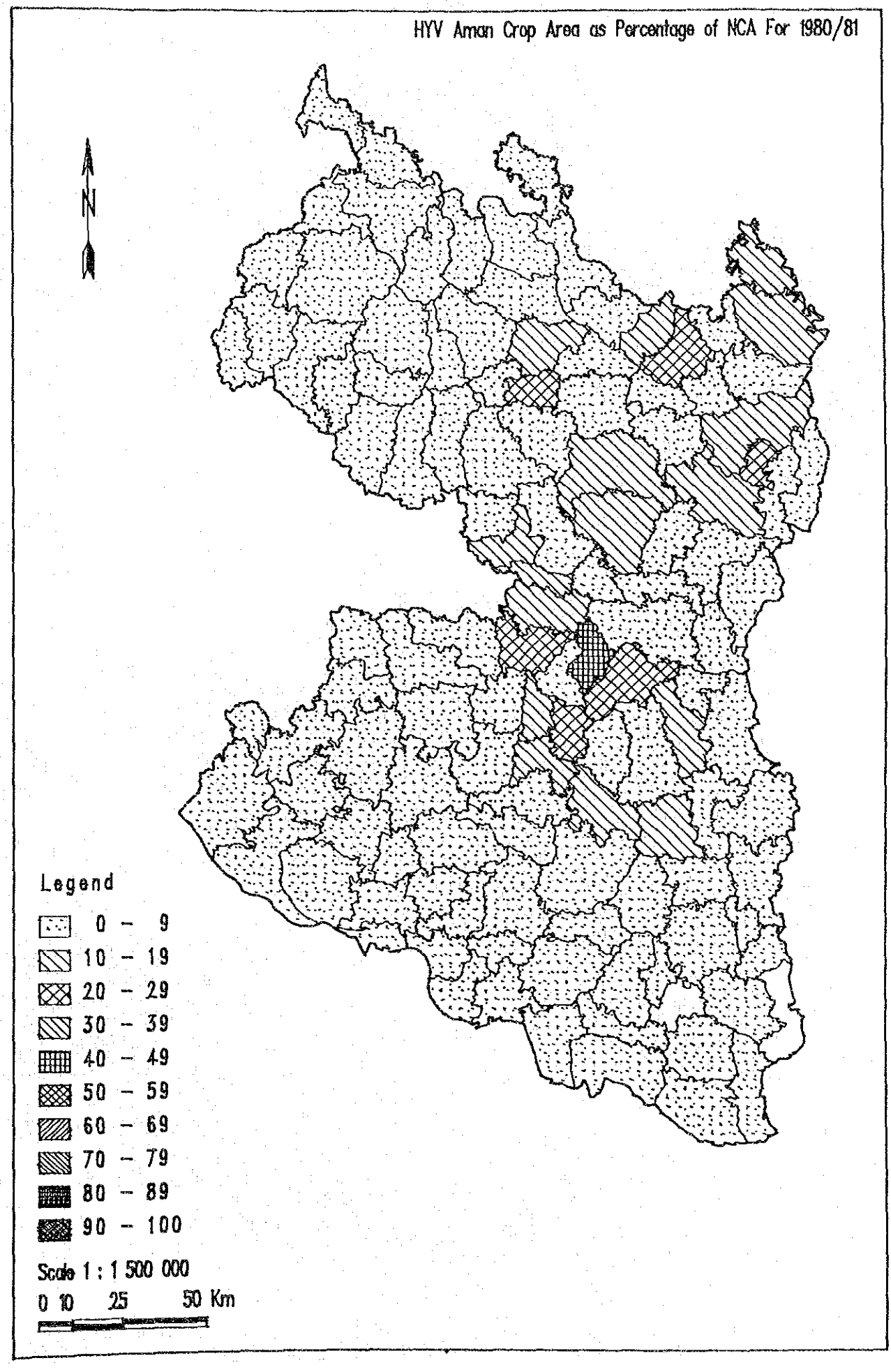
Map 6

Transplanted Aman 1987



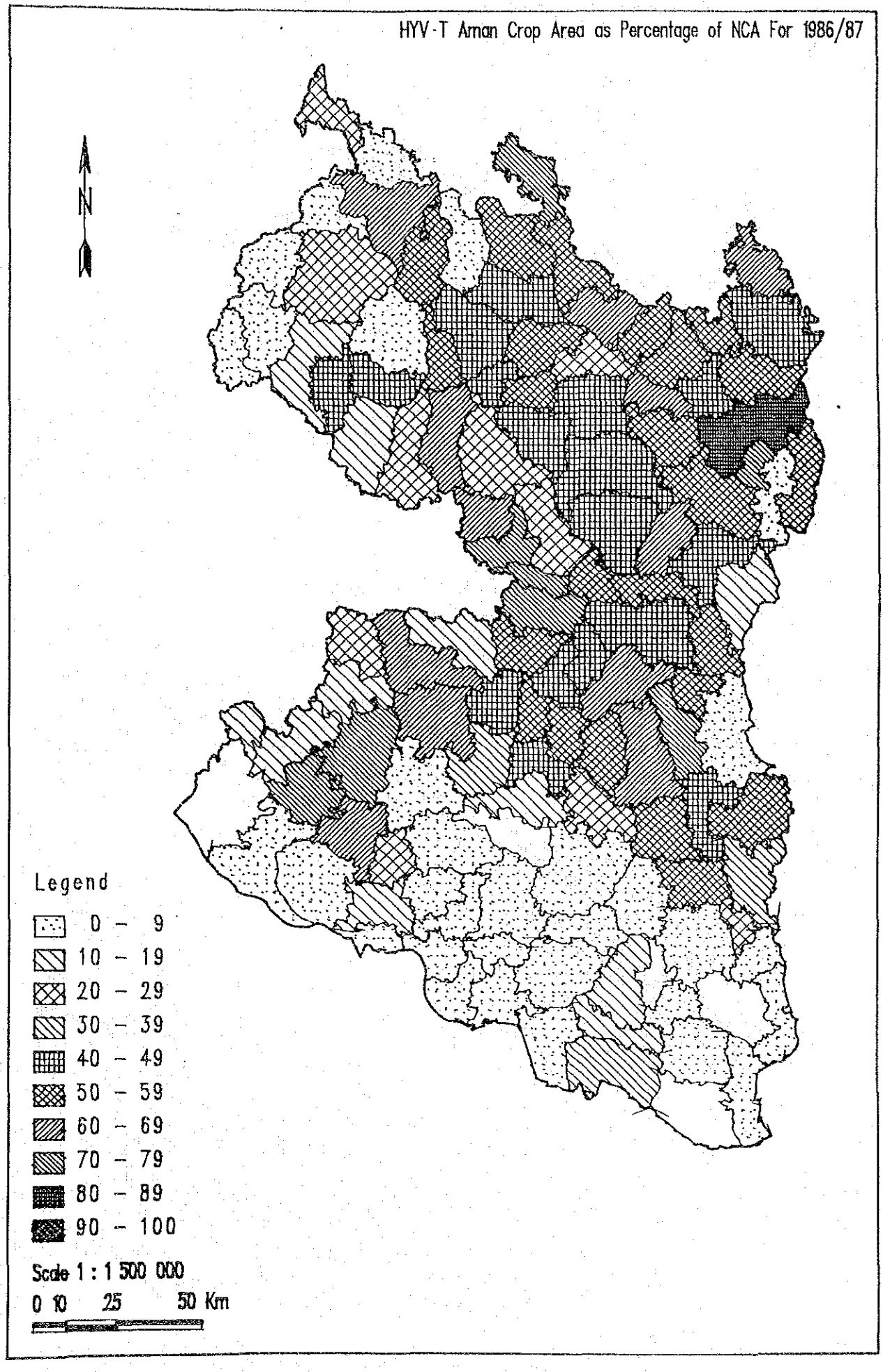
Map 7

HYV Aman 1980



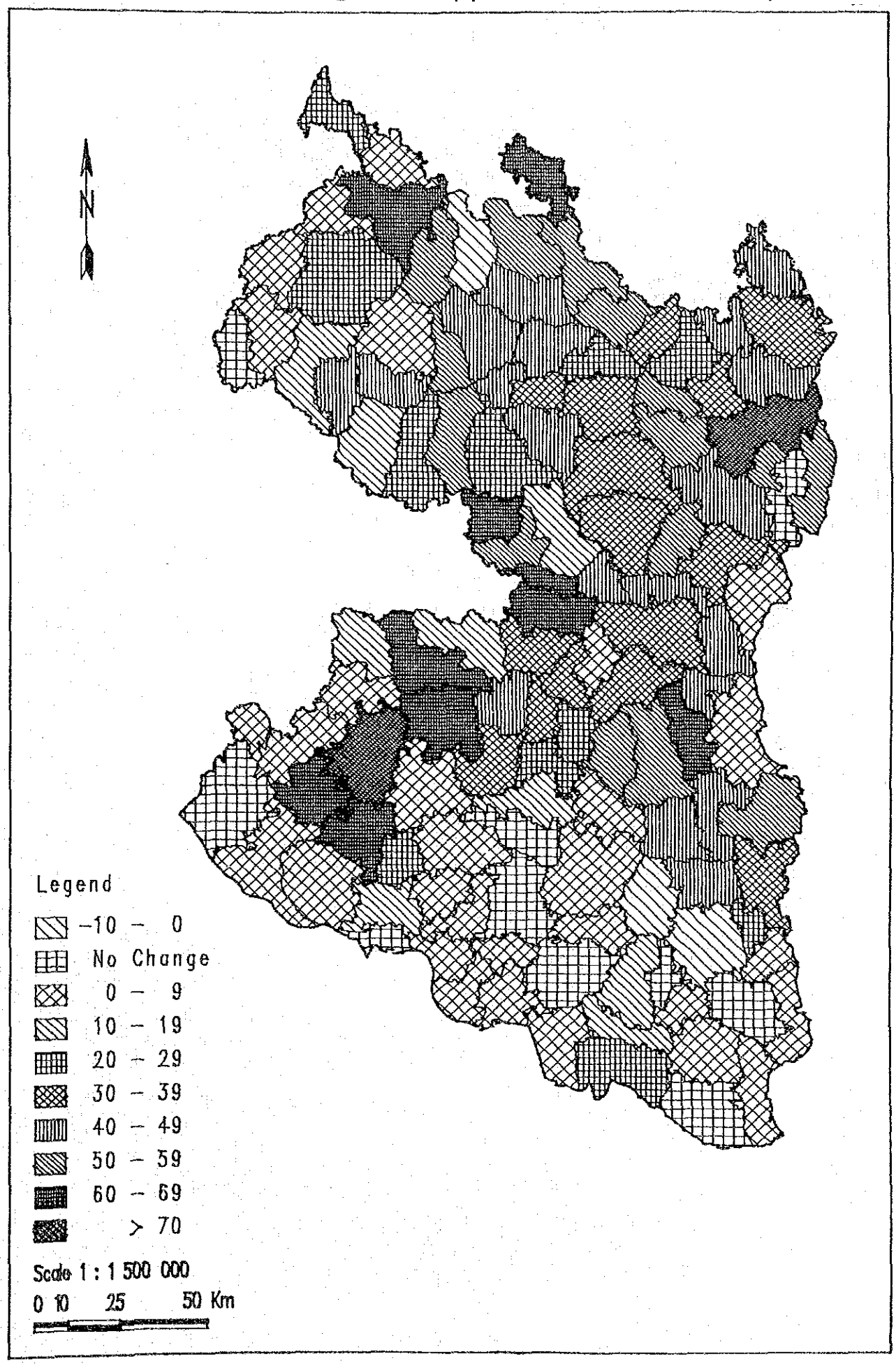
Map 8

HYV T Aman 1987



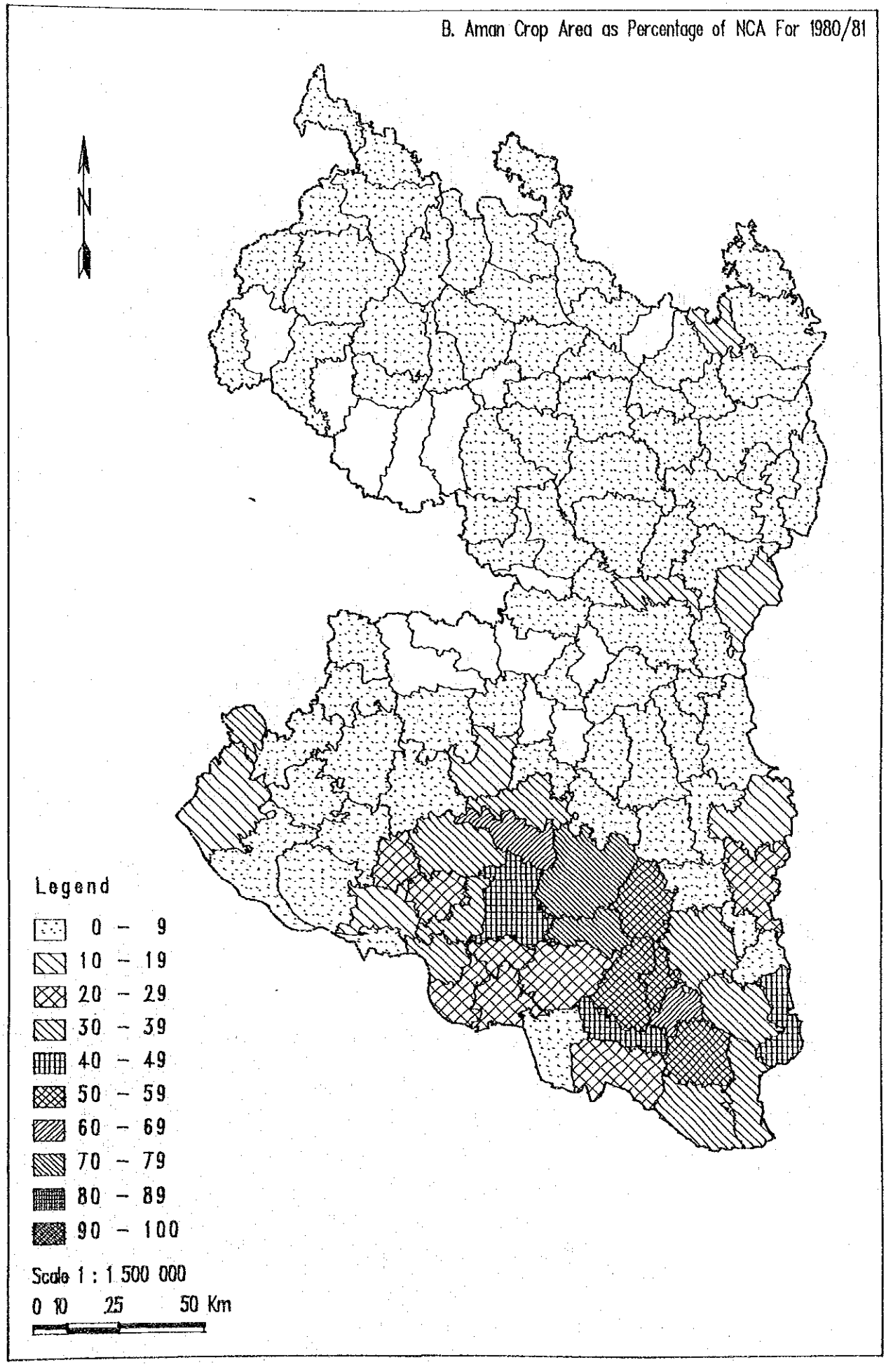
Map 9

Change in Cropped Area of HYV Aman, 1980-87



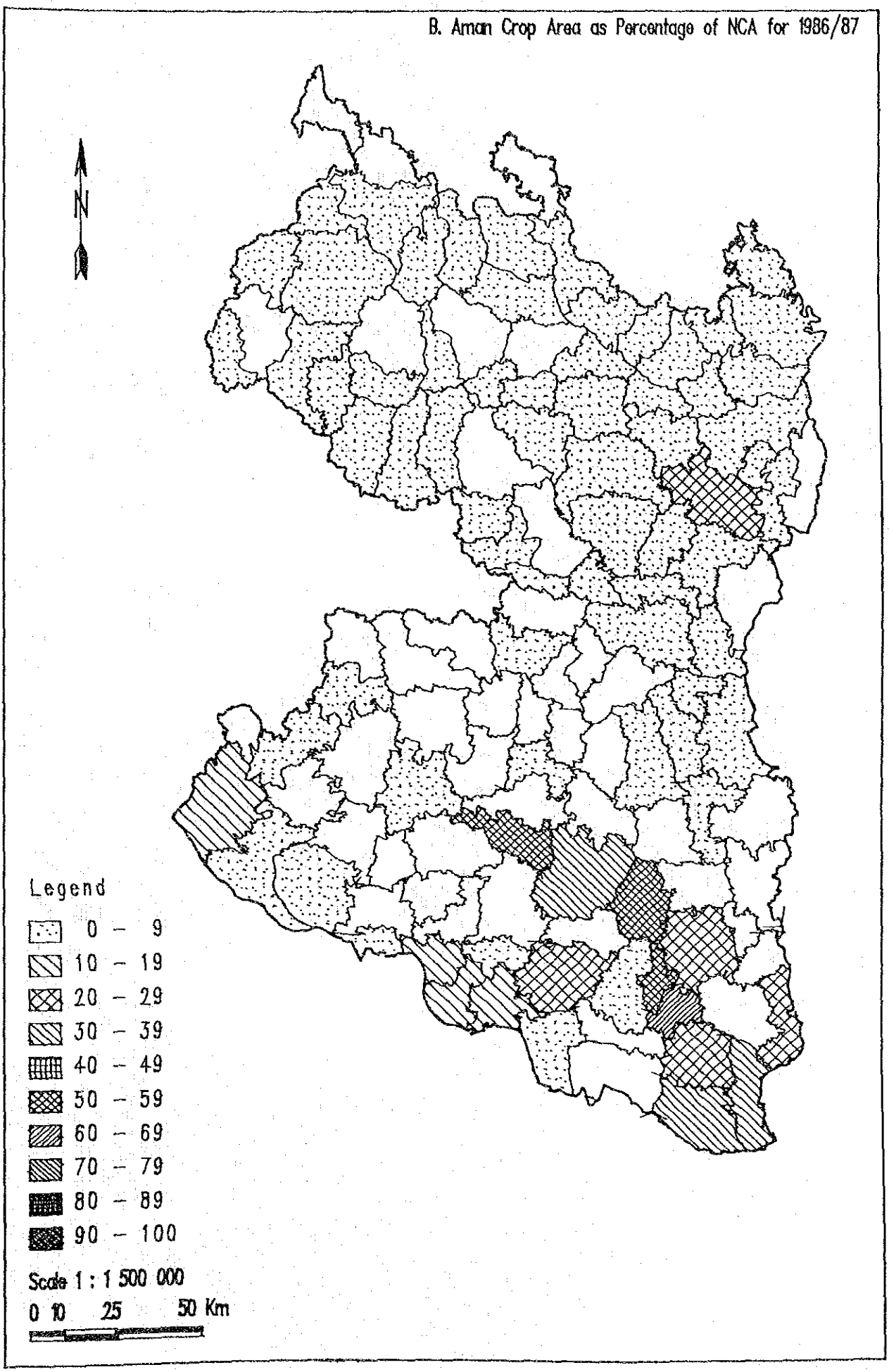
Map 10

Broadcasted Aman 1980



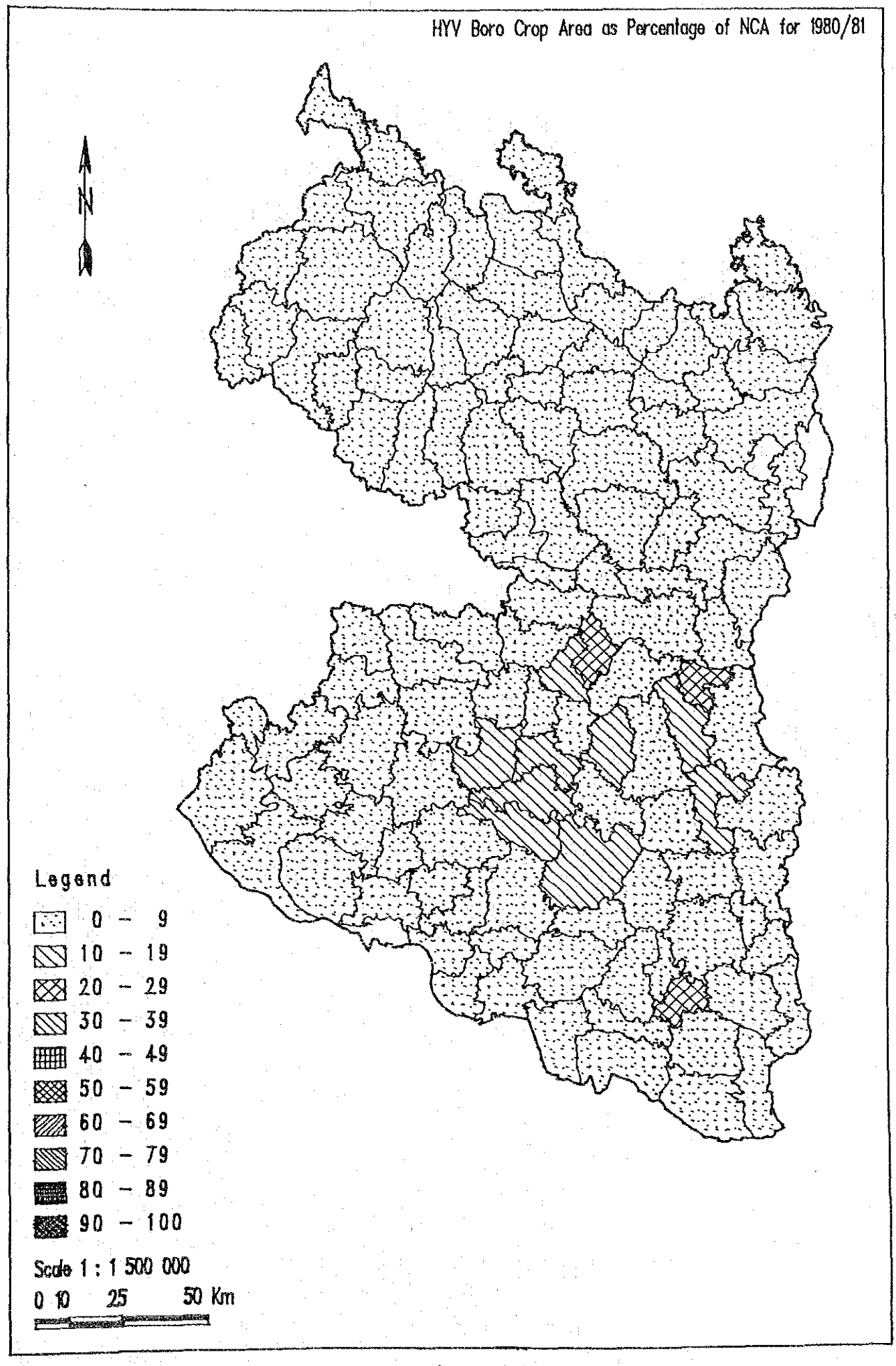
Map 11

Broadcasted Aman 1987



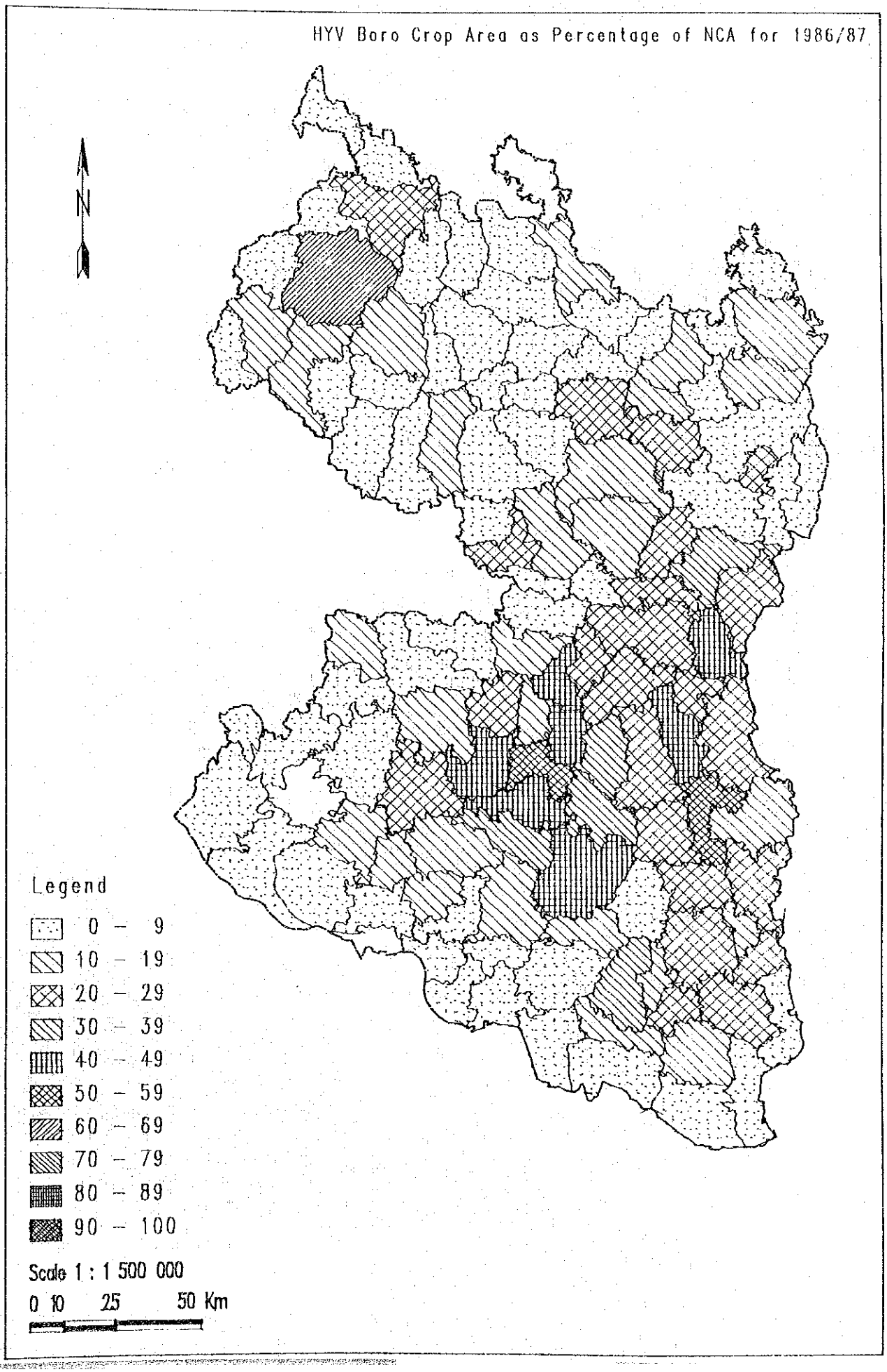
Map 12

HYV Boro 1980



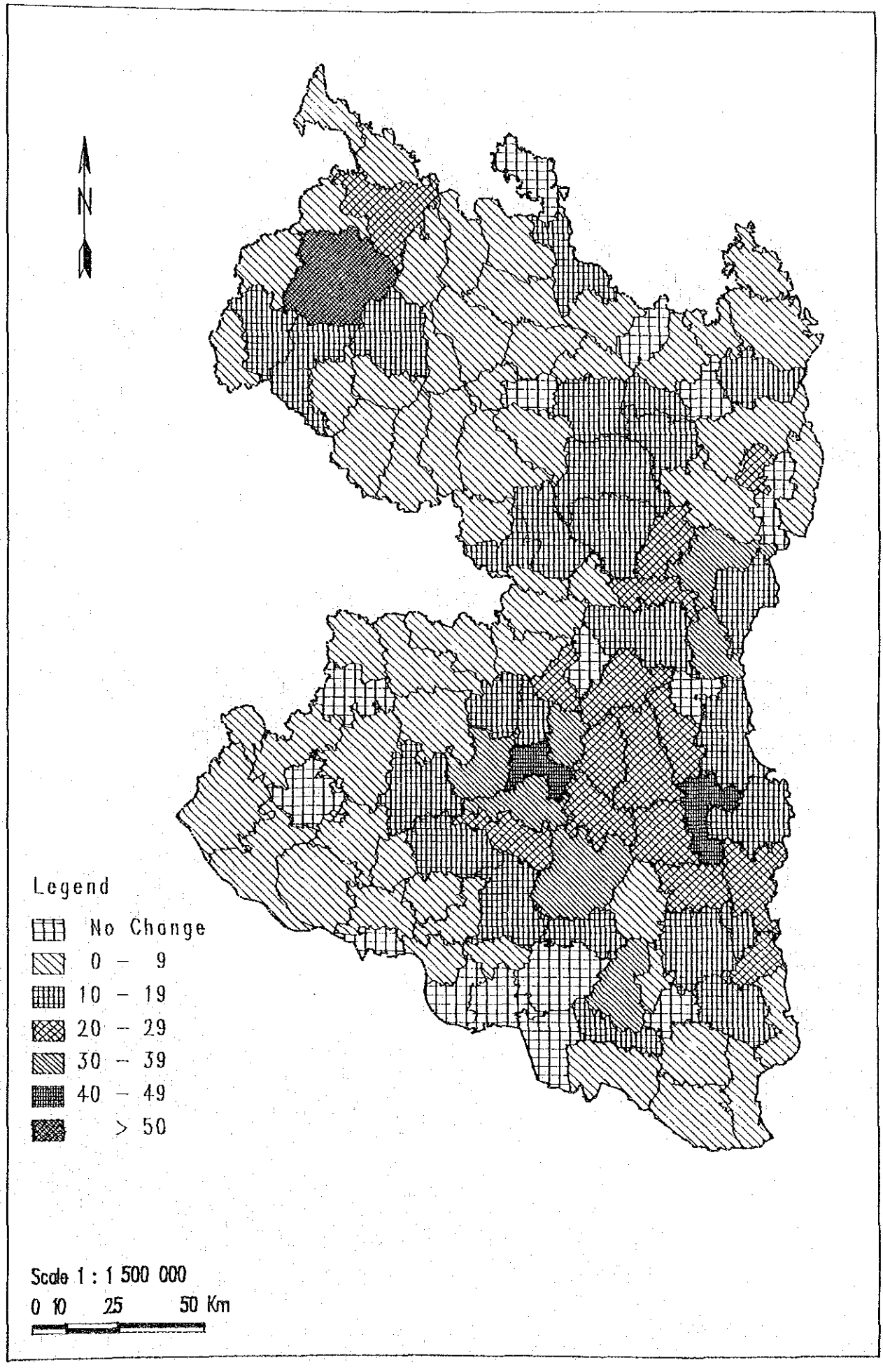
Map 13

HYV Boro 1987



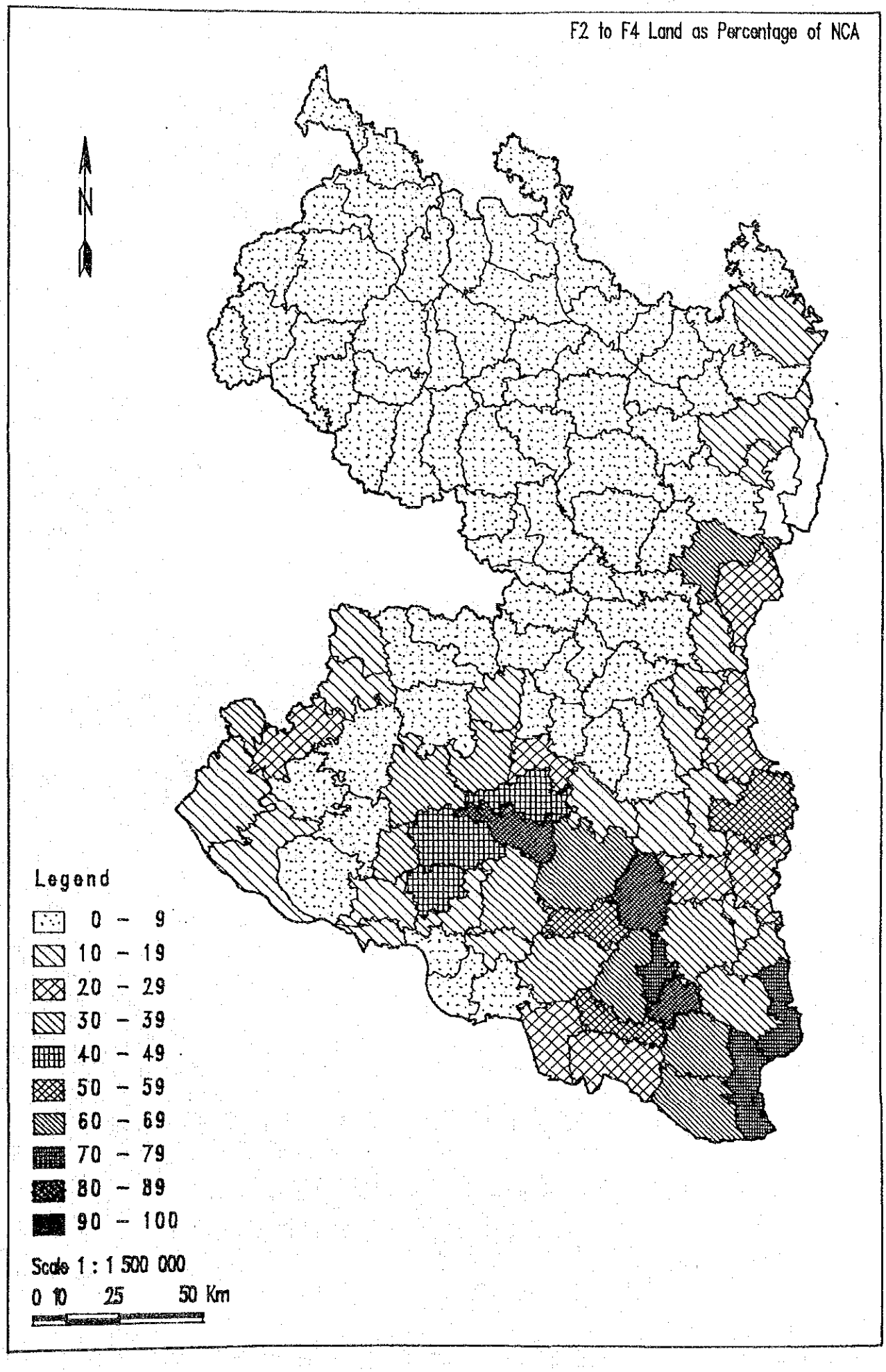
Map 14

Change in Cropped Area of HYV Boro, 1980-87



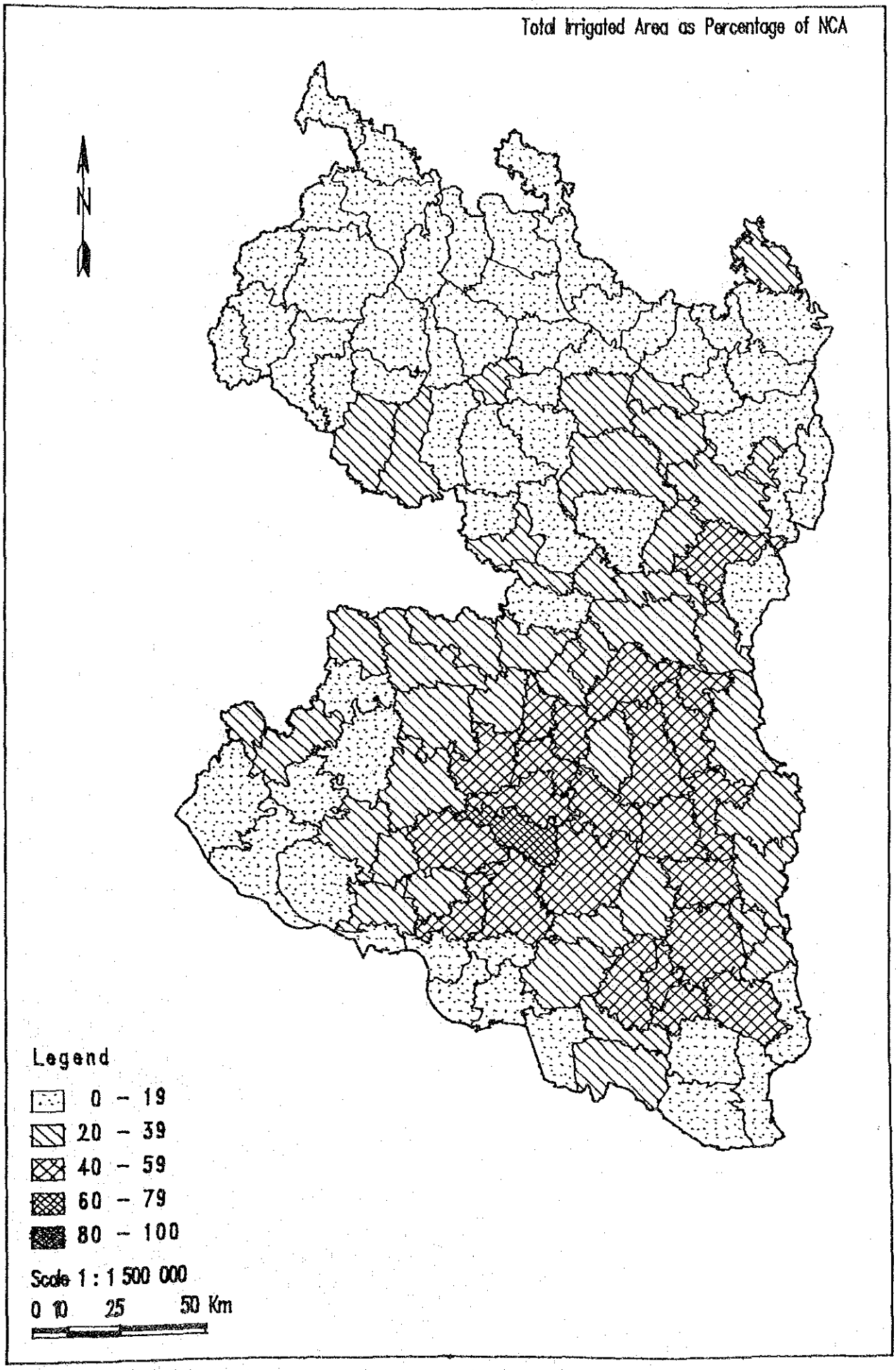
Map 15

Flood Phase



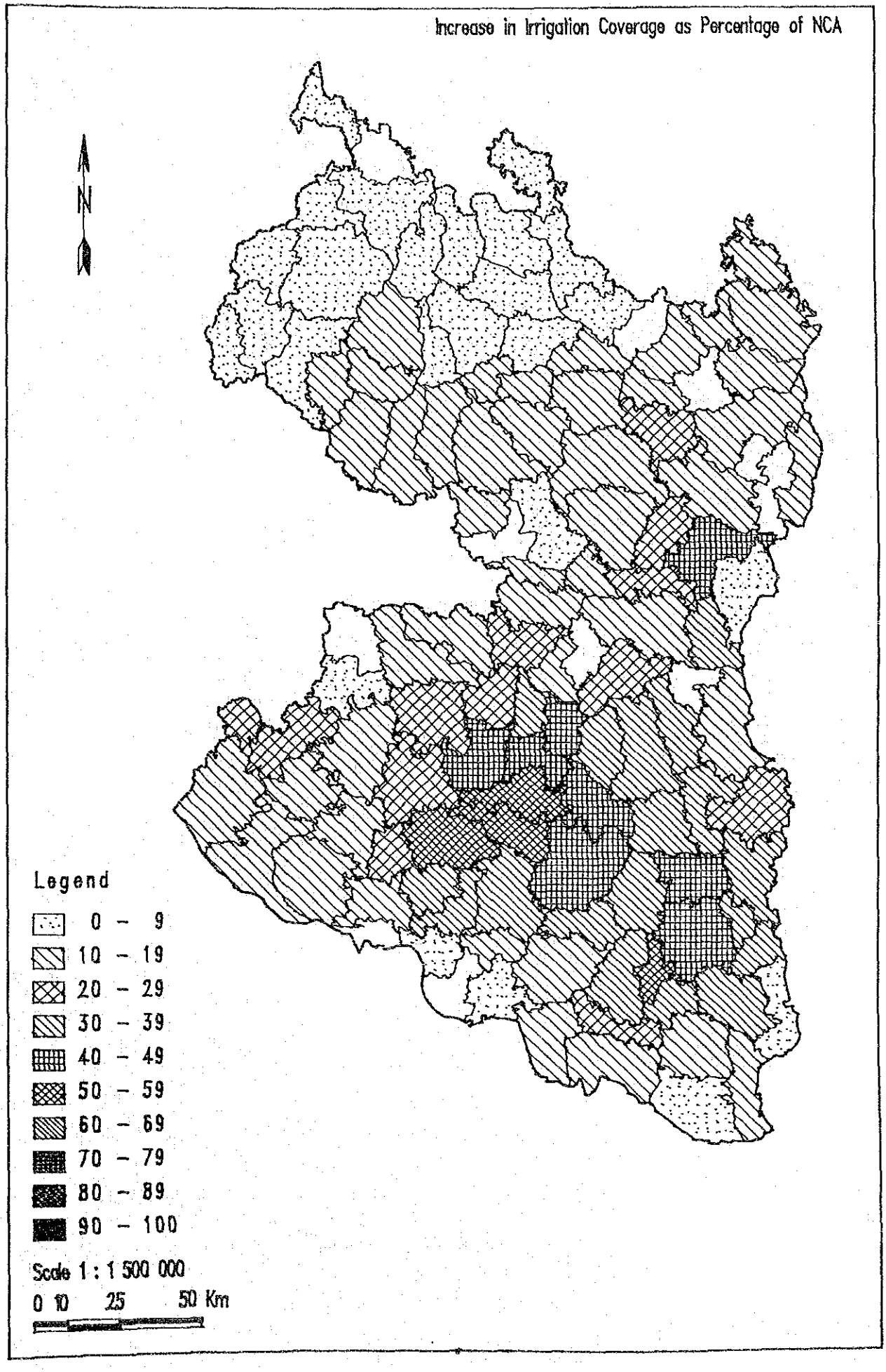
Map 16

Irrigation Coverage 1989



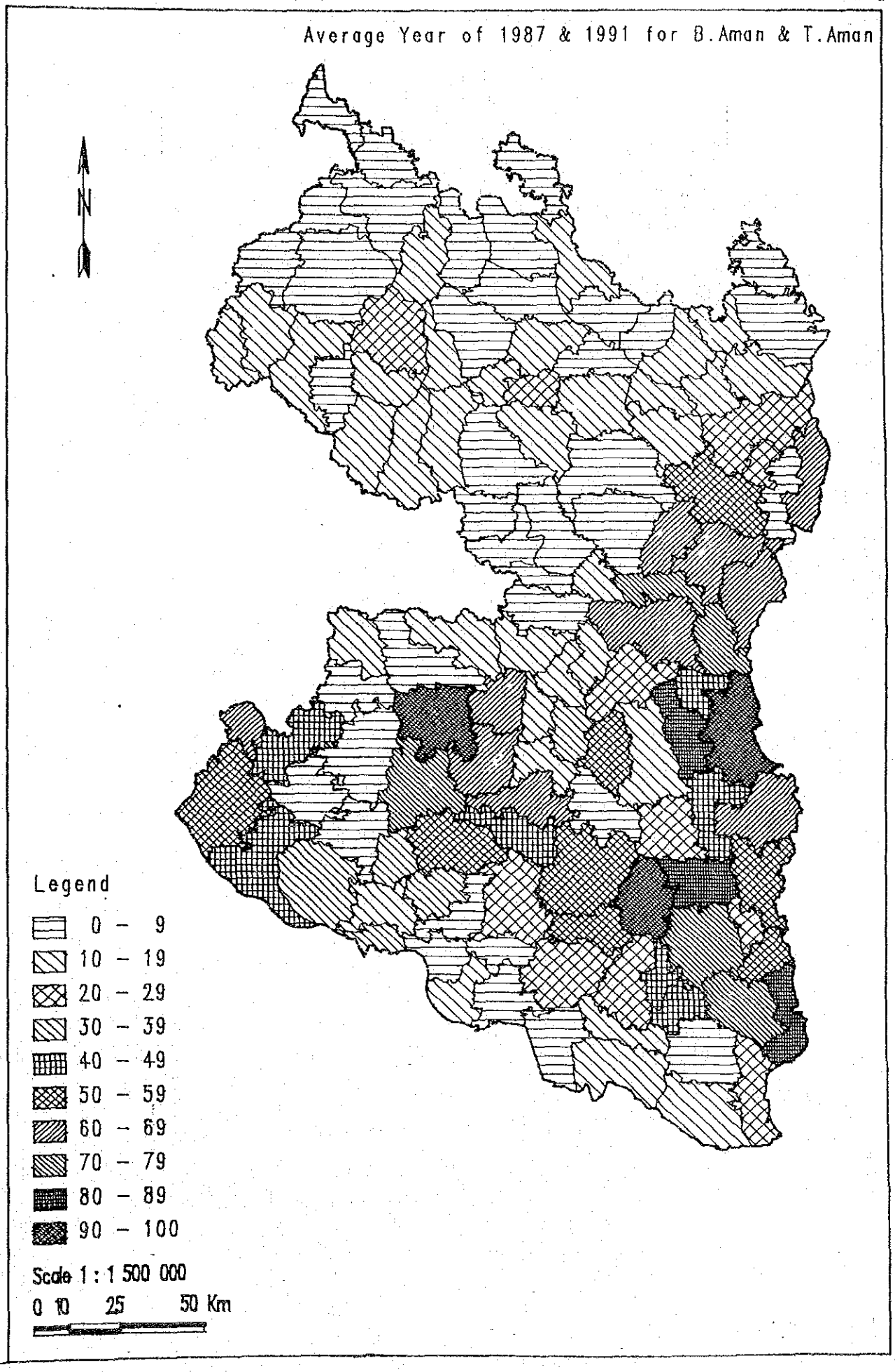
Map 17

Increase in Irrigation Coverage 1981 to 1989



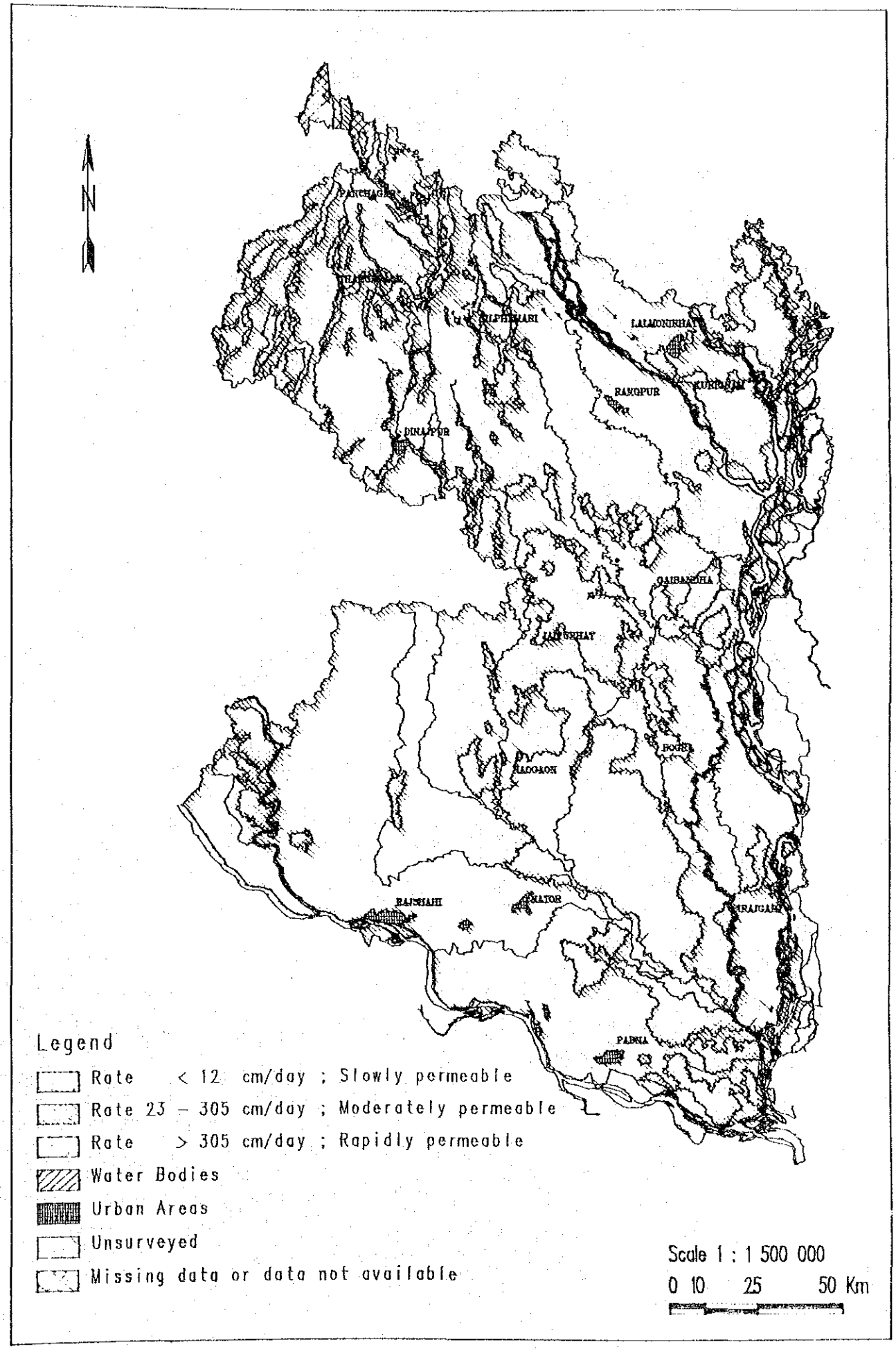
Map 18

Crop Damage



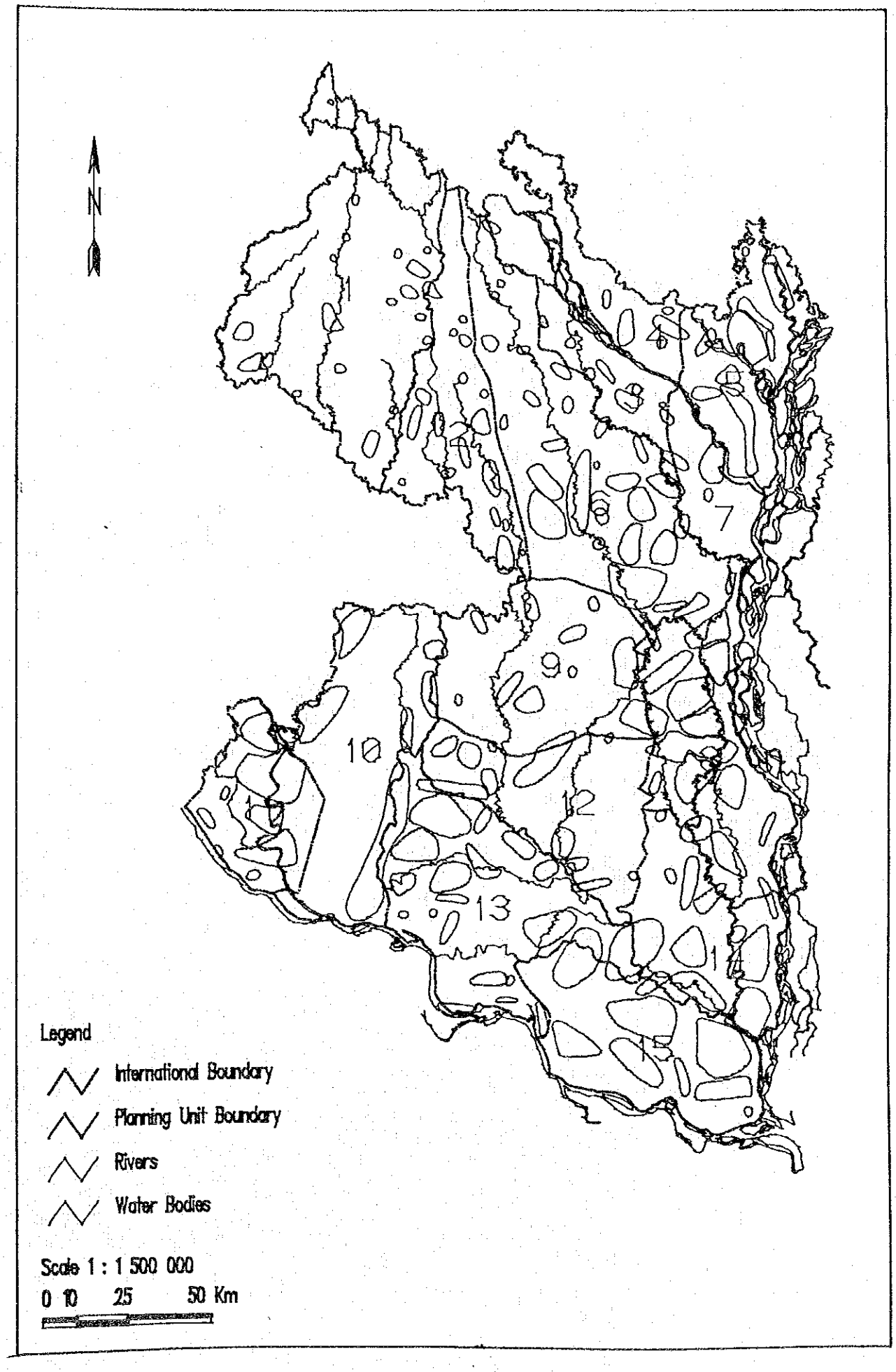
Map 19

Soil Permeability Map



Map 20

Water Bodies



PART 2

PLANNING UNITS

CONTENTS

PLANNING UNITS

List of Tables:

A map of the planning unit unit follows each chapter

PLANNING UNIT 1

THAKURGAON

1.1 General

This unit consists of Thakurgaon district and most of Panchagarh and Dinajpur districts. The eastern side of the boundary is demarcated by the Karatoya, the Dhepa, and the Punarbhaba rivers. On all other sides is India.

Basic data of the planning unit is presented in Table 1.1. The gross area is 421000 ha.

The population of the planning unit in 1981 was 1.86 million. Population density is 4.4 person/ha gross, significantly lower than the regional average.

Population densities in the area are relatively uniform, but there is a tendency towards higher densities in the eastern part of the area. This variation is attributed to the different land capabilities in terms of agricultural production. The relatively higher hilly area of Tetulia poses problems for high cropping intensities whilst it is also somewhat isolated in terms of communications.

1.2 Agriculture

1.2.1 Soils

The planning unit lies within MPO planning area 7. It is covered by the old Himalayan piedmont plain physiographic unit with a small part of the Barind tract in the south-east.

The area is climatically somewhat different to other parts of the region, experiencing relatively cold winter seasons although the monsoon season can be characterised by very intensive rainfalls.

The topography of the area is relatively steep with ground elevations varying from 91m to 31m above mean sea level; the overland slope is almost 1 metre per kilometre sloping to the south east.

Topographically most of the area has nearly level broad ridges and shallow basins with irregular relief alongside rivers and infilled channels. The original deposits were sandy, but they have generally weathered to produce well oxidised loamy soil. Deep, rapidly permeable sandy loams predominate on higher ridges and silty clay to clays on basins and depressions.

1.2.2 Cropping Patterns

Almost all the land in the planning unit is highland or medium-highland, therefore there are very few areas of prolonged flooding. Cropping patterns are therefore primarily determined by factors such as extent of irrigation soil and climate. The prevalence of highly permeable soils on higher ridges, for example, has resulted in a relatively high degree of wheat cultivation in this area.

Cropping patterns have been developed according to the 1989 BBS cropped area data, the MPO flood phase classification and 1989 irrigation census by AST. These data sets have been standardised to planning unit basis by GIS.

Table 1.1 Planning Unit 1 Basic Data

Thana	Percentage in Planning Unit	Percentage in Thana
ATWARI	5	100
BALIADANGI	7	100
BIRGANJ	9	90
THAKURGAON	15	100
BIRAL	8	99
TETULIA	5	100
PIRGANJ	9	100
BOCHAGANJ	5	100
BODA	10	100
PANCHAGHAR	6	100
HARIPUR	5	100
RANISANKAIL	7	100
KAHAROLE	4	83
KHANSAMA	tr	1
DINAJPUR	tr	1
DEBIGANJ	5	64

Gross Area (ha) : 421312
Nca Area (ha) : 386431

Total population (1981) : 1856666 Population Density : 4.41
(per ha Gross area)

Flood Phase :

F0 (ha) :	248319	F0 % of NCA (ha) :	64
F1 (ha) :	135126	F1 % of NCA (ha) :	35
F2 (ha) :	2985	F2 % of NCA (ha) :	1
F3 (ha) :	0	F3 % of NCA (ha) :	0
F4 (ha) :	0	F4 % of NCA (ha) :	0

Irrigation Equipment Operating :

STW 81	323	STW 89	5418
DTW 81	318	DTW 89	445
LLP 81	121	LLP 89	338
Irrigation Coverage (%) Yr 81	2	Irrigation Coverage (%) Yr 89	9

TABLE 1.2 CROPPING PATTERN

LAND TYPE	AMOUNT
F0	248319
F1	135126
TOTAL	383445
F2	2985
F3	0
TOTAL	
F4	0
GTOYAL	386431

IRRIGATION BALANCE	
HYV BOR	22138
WHEAT	3973
HYV AUS	8668
TOTAL	34779

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGATE AREA	NONIRRI AREA	TOTAL AREA	% IRRIG
F0	12421	235898	248319	5
F1	20269	114857	135126	15
TOTAL	32690	350756	383445	9
F2	2090	896	2985	70
F3	0	0	0	
F4			0	
TOTAL	34779	351652	386431	

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	20048	B. AUS	65565	HYV TAM	78047	SUGARCA	15686
WHEAT	36005	HYV AUS	7946	L.T. AMA	176316	ORCHAR	1592
POTATO	19322	JUTE	12010	VEGETAB	142		
TOBACCO	9162	OILSEEE	4965	BAMAN	4423		
PULSES	9162	SPICES	2840	SPICES	1874		
OILSEED	10080	VEGETAB	473				
SPICES	2840						
VEGETABLES	331						
Sub-Total	106950	Sub-Total	93799	Sub-Total	258928	Sub-Total	17278
Total	476955						
CROPPING INTENSITY	124						

CROPS ON F2 LANDS

HYV BORO	2090
DW AMAN	443
PULSES	0
JUTE	0
L.BORO	765
Total	3298
CROPPING INTENSITY	110

CROPS ON F3 LAND

HYV BORO	
LOCAL BORO	
D.W.AMAN	
PULSES	
Total	
CROPPING INTENSITY	

Grand Total	480253
CROPPING INTENSITY	124

The cropping patterns are shown in Table 1.2. Overall cropping intensity is only 124%. Irrigation coverage is very low, estimated at only 9% of NCA. HYV boro is therefore relatively less important than local t. aman.

1.2.3 Crop Damage

Crop damage due to floods is not serious in normal years; damage is primarily related to the t.aman crop. In the 1987 floods, about 27% of the planted area of t. aman was fully damaged, whereas in 1991 the corresponding figure was about 6%. The 1987 damage to t. aman was worse in the thanas in the south of the unit. Both those years were quite severe monsoons for this region of the country.

1.3 Fisheries

The planning unit comprises about 10500 ha of water areas producing in the region of 5000 MT of fish annually. The area is mainly high ground with few flooding problems. Fish farming dominates.

Fishing Sector	Area (ha)	Yield (KG/ha)	Production (mt)
Beels	24	460	11
Rivers	392	89	35
Flood Plains	3000	69	207
Total Capture Fish:	3416		253
Fish Ponds:			
- Cultured	3675	950	3491
- Culturable	2314	450	1041
- Derelict	1044	120	125
Total Culture Fish:	7033		4657
Overall Total:	10449		4910

1.4 Infrastructure

1.4.1 Major Infrastructure and Industries

The main roads in the area are the Dinajpur - Thakurgaon - Panchagarh road and the Panchagarh - Tetulia road.

The Dinajpur - Panchagarh railway line is situated in this planning unit.

There are sugar mills at Thakurgaon and Panchagarh.

1.4.2 Infrastructure Damage

The 1987 flood caused damage estimated at Tk. 94 lac to BWDB infrastructure in planning units 1 and 2, and Tk. 137 lac to LGEB infrastructure in planning unit 1. This was mainly located in the lower reaches of the Dhepa and Atrai rivers.

In 1988 the damage to BWDB infrastructure was Tk. 137 lac in planning unit 1. This occurred along the Dhepa and Punarbhaba rivers but also extensively around Panchagarh on the Upper Karatoya (Atrai). Damage to LGEB infrastructure in the same year was Tk. 1607 lac (including planning unit 2), distributed throughout the planning unit. Significant damage however occurred around Thakurgaon. Damage to R&H infrastructure in 1988 was Tk. 92 lac, mainly in the Panchagarh area.

1.5 Special Issues

The major issue in flood planning for this unit is cross-border flows, both from India through the Atrai and spills from the Teesta, and to India through the Tangon and Punarbhaba.

Another critical issue in terms of kharif season irrigation is the frequency of occurrence of dry periods in the monsoon period. The north west region is particularly prone to dry spells during the monsoon; hence the need for occasional HYV aman irrigation in the region. Any improved drainage will increase the need for irrigation. However, there is excess rainfall (rainfall minus potential evapotransportation) during the monsoon. This excess turns to run-off to drain into the southern Atrai/Chalan Beel basin area.

1.6 Hydrology and Morphology

The main rivers in the unit are the Atrai, Karatoya and Punarbhaba.

The River Atrai originates from the Ghoramara and Karatoya rivers in India. The river in the upstream reaches is relatively steep, the average slope being about 0.00035. The river at the upstream section maintains a width of about 200 m and 5m depth of flow, particularly in the Dinajpur area.

The Punarbhaba river has also a slightly meandering form, it maintains a width of about 150 m and an average depth of about 4.5 m. The average river bed slope has been estimated to be 0.000266. The river has a tendency of bank erosion near Dinajpur town, however this is probably noticeable because of the fixed reference marks which provide more of a gauge than is found in the more rural areas.

For estimating the flood peaks both MPO and NWRS analyses were used. Flooding conditions for a 20 year return period at different locations in the planning unit are presented in Table 1.3. MPO used Log Pearson Type II analysis and NWRS used the Gumbel Distribution Method.

Table 1.3 Flood Water Levels in Planning Unit 1 (1:20)

River	Hydrometric St.	W L m(pwd)	GL m(pwd)	Source
Atrai	Ghoramaraghat	62.72	61.0	MPO
Atrai	Debigonj	55.99	55.0	MPO
Atrai	Khansama	45.42	45.7	MPO
Karatoya	Panchagarh	72.00	71.0	MPO
Tangon	Ranigonj	61.23	63.0	MPO
Tangon	Thakurgaon	51.03	53.0	NWRS
Tangon	Kodalkatigaon	35.47	37.0	NWRS
Punarbhaba	Pran Nagar	43.29	44.0	MPO
Punarbhaba	Phulhat	34.40	33.0	NWRS

The discharge frequency characteristics for the major river systems in the planning units are given in Table 1.4.

Table 1.4 Flood Flow Frequency Analyses (maximum daily values)

River	Station	Discharge frequency (m^3/s)			Source
		2.33 Yr	10 Yr	20 Yr	
Karatoya	Panchagarh	783	1940	2850	MPO
Atrai	Khanshama	1850	3150	3710	MPO
Dhepa	Kantanagor	805	1250	1450	MPO
Punarbhaba	Pran Nagar	78	249	403	MPO
Punarbhaba	Phulhat	495	2152	2786	NWRS
Tangon	Thakurgaon	252	367	455	MPO
Tangon	Kodalkathi	184	367	487	MPO

The main climatological factor which influences flooding in the area is rainfall. The average annual rainfall varies between 1700mm and 2800mm. Monsoon rainfall data for Dinajpur is given in Table 1.5.

Table 1.5 Rainfall (mm/month)

	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Dinajpur	364	594	245	348	438	909	944	458	267	742	843	891

Source: FAP2

1.7 Existing FCD Developments

The planning unit lies mainly within MPO planning area 7, with a small part within planning area 10.

Punarbhaba Embankment Project

The Punarbhaba Right and Left embankment projects were executed long before the provision of flood protection facilities of Dinajpur town and the adjoining flood affected areas.The gross area of Punarbhaba right and left embankment project is about 5720 ha. The embankments are under rehabilitation under Food For Work (FFW) activities. The following are the basic characteristics of the Punarbhaba Embankment Project:

Left embankment : 16 Km
Right Embankment: 10 Km

There are a number of irrigation projects situated in the area including:

- Thakurgaon Tubewell Irrigation Project
- Tangon Barrage Project

Most of the irrigation in the area is provided through the private sector by the fielding of shallow tubewells and low lift pumps.

1.8 Flooding and Drainage Problems

No information is available on changes to flows coming from India. Data and flooding conditions under present circumstances were therefore investigated.

Analysis of the GIS statistics in Table 1.1 indicates that there is virtually no F2 - F4 land in the planning unit. Therefore the area in general is not subject to prolonged and deep flooding. This assumption is supported by the cropping patterns found, which have a relatively high proportion of t. aman.

The area experiences inundation due to flash floods from the upper reaches of the drainage channels in India. These flash floods tend to generate spillage which cause damage both to crops and infrastructure. However, since the duration of inundation is short, agricultural damage through crop submergence is generally on the low side (Section 1.2.3). It tends to be more severe in the south of the unit.

Infrastructure damage (Section 1.4.2) indicates that the main problems in this unit from flash flooding lie along the Dhepa and Punarbhaba rivers. This is dealt with in planning unit 2. Further west, damage along the Tangon is relatively minor, indicating that this river is not susceptible to flash flooding.

There are problems of river erosion at Panchagarh town, which is being threatened by the river Karatoya (Atrai); a part of the town has already been washed away by the river and the existing road bridge is under threat.

1.9 Development Options

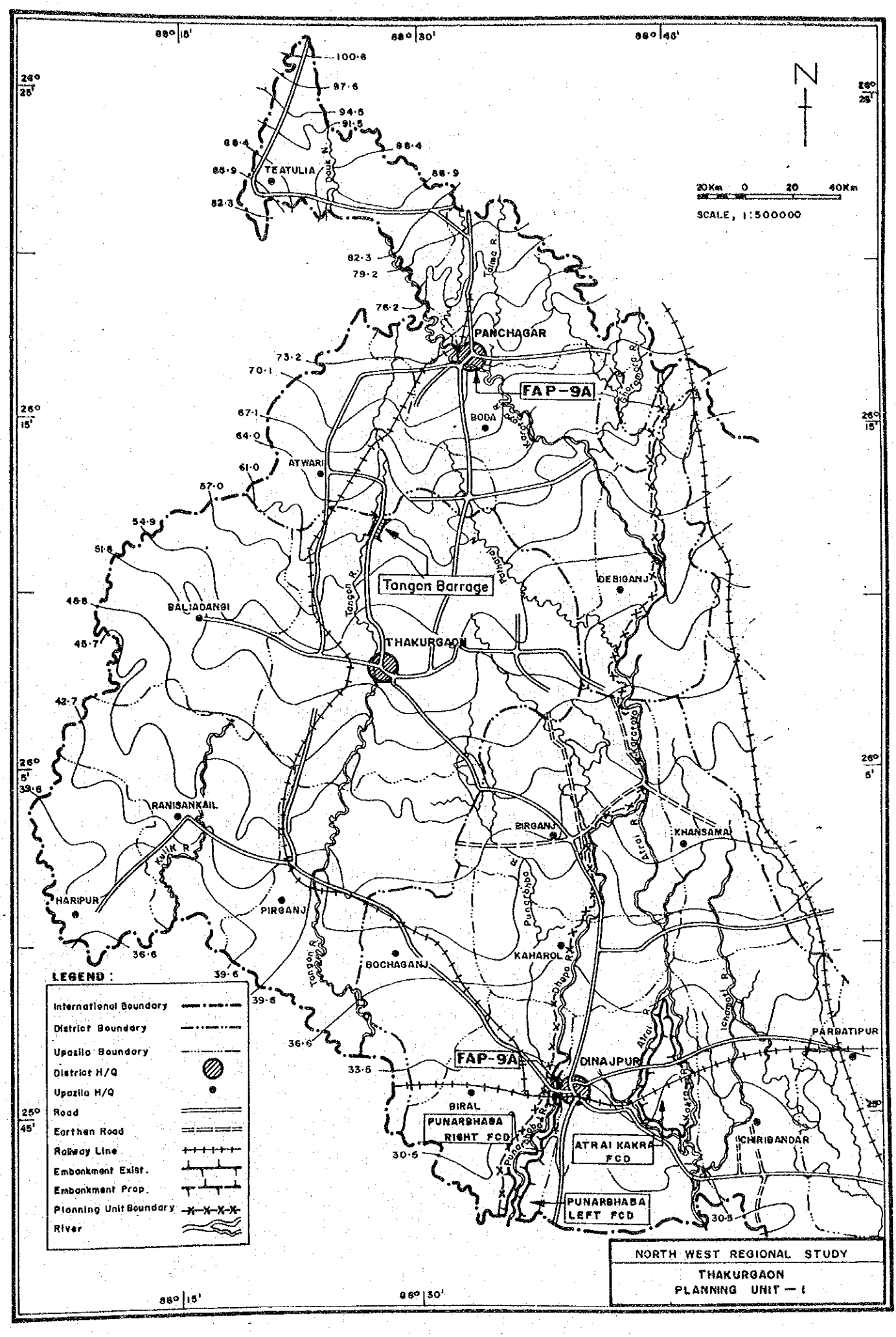
1.9.1 General

In planning unit 1 flooding generally takes the form of flash floods of relatively short duration. The main benefits from flood control would therefore be reduced crop and infrastructure damage and even this damage appears to be relatively slight. It is therefore felt that in general major structural works are not appropriate at present. This also takes into account the undesirability of increasing cross-border flows into India and to the downstream of the Atrai where it re-enters Bangladesh.

1.9.2 Town Protection Schemes

Panchagarh town is under threat from the Karatoya and a part of the town has been already lost through erosion. FAP-9A has proposed an integrated plan for flood control, drainage and river training. The proposed scheme involves construction of flood embankment along the Karatoya, drainage improvement and construction of river training works.

Localised flooding round Thakurgaon also appears to be a problem. Appropriate counter-measures could be implemented. The measures suggested would not have significant downstream impacts in regional terms.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20Km 0 20 40Km
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97·6
94·5
91·5
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82·3
79·2
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73·2
70·1
67·1
64·0
61·0
57·0
54·9
51·8
48·8
45·7
42·7
39·6
36·6
33·5
30·5
TEATULIA
Dudh Kumar R.
Tista R.
PANCHAGAR
FAP-9A
Karatoya R.
BODA
ATWARI
Tangon Barrage
Tangon R.
Punarbhaba R.
DEBIGANJ
BALIADANGI
THAKURGAON
RANISANKAIL
Kulik R.
HARIPUR
PIRGANJ
BIRGANJ
Atrai R.
KHANSAMA
Punarbhaba R.
BOCHAGANJ
KAHAROL
Karatoya R.
Atrai R.
Ichamati R.
PARBATIPUR
FAP-9A
DINAJPUR
BIRAL
PUNARBHABA RIGHT FCD
ATRAI KAKRA FCD
PUNARBHABA LEFT FCD
Mohra R.
ICHRIBANDAR
LEGEND :
International Boundary
District Boundary
Upazila Boundary
District H/Q
Upazila H/Q
Road
Earthen Road
Railway Line
Embankment Exist.
Embankment Prop.
Planning Unit Boundary
River
NORTH WEST REGIONAL STUDY
THAKURGAON
PLANNING UNIT — I

PLANNING UNIT 2

UPPER ATRAI

2.1 Basic Data

The planning unit consists of part of Panchagarh, Dinajpur and Nilphamari districts. The eastern boundary of the unit is the railway that passes through Parbatipur, Nilphamari upto the Indian border on north, on north and south is India, on west is the Atrai, the Dhepa and the Punarbhaba river.

Basic data of the planning unit is presented in Table 2.1. The gross area is 190000 ha.

The population in 1981 was 1.15 million. Population densities are about average for the region, at 6.07 per ha gross. Population densities in the area are relatively uniform, but there is a tendency towards higher densities in the south eastern part of the area and along the boundary with Rangpur district.

2.2 Agriculture

2.2.1 Soils

The planning area comprises the old Himalayan piedmont plain, Teesta flood plain and the Barind tract physiographic units.

The topography of the area is relatively steep with ground elevations varying from 91m to 31m above mean sea level; the overland slope is almost 1 metre per kilometre sloping to the south east.

The area is climatically somewhat different to other parts of the region experiencing relatively cold winter seasons although the monsoon season can be characterised by very intensive rainfalls.

Topographically most of the areas have nearly level broad ridges and shallow basins with irregular relief alongside rivers and infilled channels. The original deposits were sandy, but they have generally weathered to produce well oxidised loamy - soil. Deep, rapidly permeable sandy loams predominate on higher ridges and silty clay to clays on basins and depressions.

2.2.2 Cropping Patterns

Almost all the land in the planning unit is highland or medium-highland, therefore there are few areas of prolonged flooding. Overall cropping intensity is about 162% (based on 1989 BBS statistics), and irrigation coverage is about 16% of NCA. In the rabi/boro season, the area under wheat and under HYV boro is about the same. In the aman season, HYV t. aman is now more important than local t. aman.

Cropping patterns for the planning unit are given in Table 2.2.

Table 2.1 Planning Unit 2 Basic Data

Thana	Percentage in Planning Unit	Percentage in Thana
DEBIGANJ	6	36
BIRAL	tr	1
CHIRIRBANDAR	17	100
BIRGANJ	2	10
BIRAMPUR	6	62
KAHAROLE	2	17
HAKIMPUR	1	25
KHANSAMA	9	99
BODA	tr	0
DINAJPUR	19	99
DOMAR	5	36
PANCHBIBI	tr	1
PARBATIPUR	13	58
FULBARI	10	96
NILPHAMARI	8	43
SAIDPUR	1	19

Gross Area (ha) : 189553
Nca Area (ha) : 169902

Total population (1981) : 1151344 Population Density : 6.07
(per ha Gross area)

Flood Phase :

F0 (ha) :	86144	F0 % of NCA (ha) :	51
F1 (ha) :	81343	F1 % of NCA (ha) :	48
F2 (ha) :	2413	F2 % of NCA (ha) :	1
F3 (ha) :	0	F3 % of NCA (ha) :	0
F4 (ha) :	0	F4 % of NCA (ha) :	0

Irrigation Equipment Operating :

STW 81	480	STW 89	3899
DTW 81	225	DTW 89	528
LLP 81	142	LLP 89	177
Irrigation Coverage (%) Yr 81	5	Irrigation Coverage (%) Yr 89	16

TABLE 2.2 CROPPING PATTERN

LAND TYPE	AMOUNT(HA)
F0	86144
F1	81343
TOTAL	162686
F2	2413
F3	
TOTAL	
GTOYAL	169902

IRRIGATION BALANCE	
HYV BOR	25524
WHEAT	830
HYV AUS	830
TOTAL	27184

F4

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGATE AREA	NONIRRI AREA	TOTAL AREA	% IRRIG
F0	8614	77530	86144	10
F1	16639	64704	81343	20
TOTAL	25254	142233	167487	15
F2	1930	483	2413	70
F3			0	
F4			0	
TOTAL	27184	142718	169902	

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	23594	B. AUS	29364	HYV TAM	84397	SUGARCA	1530
WHEAT	26328	HYV AUS	7729	L.T. AMA	60059	ORCHAR	609
POTATO	7561	JUTE	9946	VEGETAB	299		
TOBACCO	1957	OILSEEE	657	SPICES	1722		
PULSES	10108	SPICES	2609				
OILSEED	668	VEGETAB	996				
SPICES	2609						
VEGETABLES	280						
Sub-Total	73105	Sub-Total	51301	Sub-Total	144755	Sub-Total	2139
Total	271300						
CROPPING INTENSITY	167						

CROPS ON F2 LANDS

HYV BORO	1930
DW AMAN	393
OILSEED	667
PULSES	197
Total	3187
CROPPING INTENSITY	132

CROPS ON F3 LAND

HYV BORO	
LOCAL BORO	
D.W.AMAN	
Total	
CROPPING INTENSITY	

Grand Total	274487
CROPPING INTENSITY	162

2.2.3 Crop Damage

Crop damage in the planning unit in not very significant is normal years. However, in the 1987 floods about 32% of the planted area of t. aman was fully damaged, and in 1991 the corresponding figure was about 11%. In both years the worst damage occurred in Dinajpur thana. Localised flooding occurs mostly due to flash floods.

2.3 Fisheries

The unit has about 6000 ha of water bodies, producing less than 1000t per year. This is mainly a fish farming area, but porous soils result in many ponds drying out for part of the year.

Fishing Sector	Area (ha)	Yield (KG/ha)	Production (mt)
Beels	24	450	11
Rivers	314	89	28
Flood Plains	3000	69	207
Total Capture Fish:	3338	-	246
Fish Ponds:			
- Cultured	1269	950	121
- Culturable	829	450	373
- Derelict	410	120	49
Total Culture Fish:	2508	-	543
Overall Total:	5846	-	789

2.4 Infrastructure

2.4.1 Major Infrastructure and Industries

The principal main roads in the area are the Saidpur-Dinajpur road and the Dinajpur-Shamjiaghat - Gobindaganj road. The Dinajpur - Saidpur railway line is situated in this planning unit.

The most important industry within the planning unit are the Dinajpur Textile Mills.

2.4.2 Infrastructure Damage

In 1987 damage valued at Tk. 94 lac occurred to BWDB infrastructure in planning units 1 and 2, whilst the LGEB infrastructure in unit 2 was damaged to the tune of Tk. 152 lac. The BWDB infrastructure was mainly damaged on the lower reaches of the Dhepa and Atrai within the planning unit. Some damage to LGEB infrastructure occurred higher up the Atrai.

The 1988 flood caused damage estimated at Tk. 86 lac to BWDB infrastructure. This was mainly on the Atrai and Kakra, but some damage also occurred higher up the Atrai. LGEB damage for planning

units 1 and 2 was estimated at Tk. 1607 lac, mainly in the lower reaches of the Atrai. Damage to R&H infrastructure was Tk. 224 ha, mainly on the Dinajpur-Phulbari and Dinajpur-Parbatipur roads.

2.5 Special Issues

The major issue in flood planning for this unit is cross-border flows, both from India through the Atrai and spills from the Teesta, and to India through the Punarbhaba and Atrai.

2.6 Hydrology and Morphology

The Atrai river is the main river whilst the Karatoya-Atrai is a tributary of the Atrai river. The river Atrai and Karatoya-Atrai are perennial rivers in their upper reaches. The river Dhepa is a distributary of the Atrai river which joins with the Punarbhaba river at Phulhat. The Atrai bifurcates at Bhushirbandar into the Atrai and Kakra rivers, which join again at Shamjiaghat.

The River Atrai originates from the Ghoramara and Karatoya rivers in India. The river in the upstream reaches is very steep, the average slope being about 0.00035 whilst the average bed slope from Atrai railway bridge is very flat at about 0.000047. The river at the upstream section maintains a width of about 200 m and 5m depth of flow, particularly in the Dinajpur area.

The Punarbhaba river has also a slightly meandering form, it maintains a width of about 150 m and an average depth of about 4.5 m. The average river bed slope has been estimated to be 0.000266. The river has a tendency of bank erosion near Dinajpur town, however this is probably noticeable because of the fixed reference marks which provide more of a gauge than is found in the more rural areas.

The Little Jamuna river originates in Dinajpur district. The average bed slope of the river is about 0.000222. The river width gradually increase with increased discharge. In the upstream reaches the river is silted up, during the dry season farmers cultivate this river bed.

Main hydrological and rainfall data are given in Table 2.3 to 2.5.

Table 2.3 Max Mean Daily Discharges (m^3/s)

Station Name	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Khansama (Atrai)	1254	2559	NR	NR	1332	207	NR	NR	675	2543	NR	NR
Phulhat (Punarbhaba)	371	1855	1890	289	345	3229	3980	3801	632	1403	814	1687
Bushirbandar (Atrai)	725	1945	998	662	706	1773	2090	1820	593	2123	1060	991

Table 2.4 Max Mean Daily Water Levels (m PWD)

Station Name	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Khansama (Atrai)	43.52	45.15	44.76	NA	43.40	44.86	45.18	NA	43.16	44.56	44.15	NA
Phulbari (Dhepa)	33.02	34.07	33.06	31.51	33.35	34.30	34.29	34.24	32.54	33.56	32.32	33.10
Bushirbandar (Atrai)	39.40	39.97	NA	38.78	39.25	40.28	NA	40.34	38.80	40.33	NA	39.22
Shamjiaghat (Atrai)	30.59	31.59	30.90	30.24	30.51	32.31	32.38	32.61	29.86	31.36	30.90	30.90

Table 2.5 Rainfall (mm/month)

	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Dinajpur	364	594	245	348	438	909	944	458	267	742	843	891

Source: FAP2

2.7 Existing FCD Developments

The planning unit lies within MPO planning area 7.

The main FCD projects are the Punarbhaba Embankment Project and the Atrai-Kakra FCD project.

The Punarbhaba Right and Left embankment projects are described under Planning Unit 1.

The Atrai-Kakra FCD project is situated in Dinjapur district, the project area lies in the area between the River Atrai and the River Kakra . The Atrai river bifurcates at Bhusirbandar and rejoins at Shamjiaghat. The gross area of the project is about 4200 ha. The left bank of River Atrai and right bank of Kakra river have been embanked to provide the protective measures. The project is on-going and is expected to be complete in 1992-93.

2.8 Flooding and Drainage Problems

Analysis of the GIS statistics in Table 2.1 indicates that there is virtually no F2 - F4 land in the planning unit. Therefore the area is not subject to prolonged and deep flooding. This assumption would be supported by the cropping patterns found, which have a relatively high proportion of t. aman.

The area experiences severe inundation due to the flash flood flows from the upper reaches of the drainage channels in India. These flash floods tend to generate the spillage flows which cause damage both to crops and infrastructure. However, since the duration of inundation is short, agricultural damage through crop submergence is generally on the low side.

Infrastructure damage in 1987 (Section 2.4.2) indicates that the main problems in this unit from flash flooding lie along the Dhepa and Punarbhaba rivers and in the Atrai-Kakra reaches. There are also problems of river erosion at Dinajpur town, which is under active threat from the Punarbhaba.

The comparison of NAM-generated discharges and conveyance capacity for rivers in the planning units confirms some flooding problems along the reach of the Atrai-Kakra, and along the Dhepa-Punarbhaba south from Kantanagai where 20-year probable discharges exceed the carrying capacity of the rivers. There do not appear to be flooding problems on the Kharkharia/Ichamati rivers which are tributaries of the Little Jamuna.

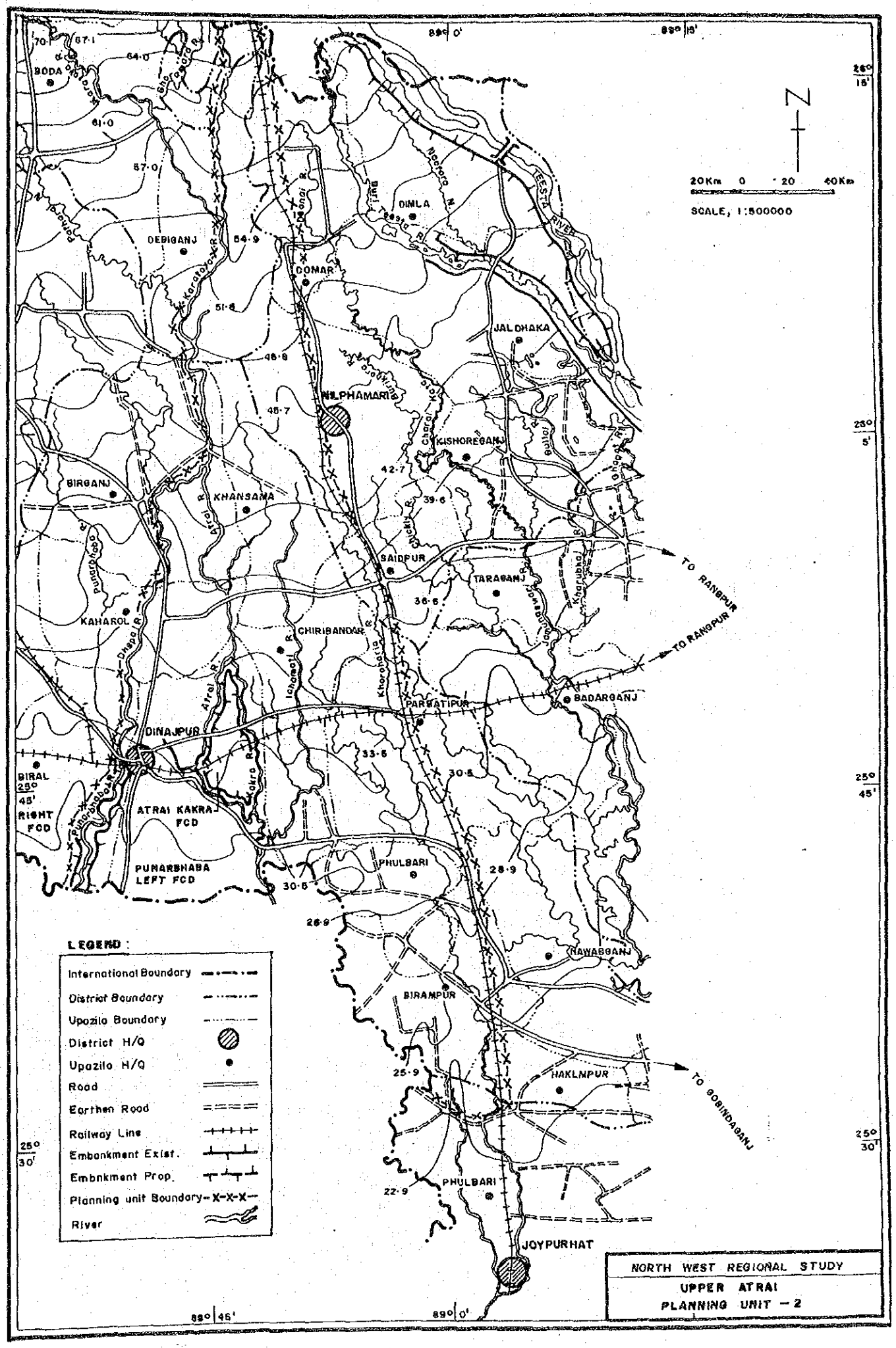
2.9 Options for Development

In the north-west section of the upstream reaches, flooding generally takes the form of flash floods of relatively short duration. The main benefits from flood control would therefore be reduced crop and infrastructure damage and even this damage appears relatively slight. It is therefore felt that in general major structural works are not appropriate at present.

In the case of the Atrai-Punarbhaba basins, flood analysis indicates that 20 year flows are likely to cause some flooding since the NAM-generated discharges are above conveyance capacity. These problems could be solved by embanking the rivers, which would cause a resultant increase in discharges downstream of 5-600m^3/s. In the case of the Atrai this would appear to be an unacceptable increase as it would add to cross-border flows and ultimately contribute to flooding in the lower Atrai. The situation of the Punarbhaba is somewhat different since there is an extensive area of beels where the river forms the international border in the south west of the region. These beels act as a natural storage basin. Increasing flows in the Punarbhaba would therefore not have detrimental effects region-wide, although increasing downstream flows is undesirable. Consideration could therefore be given to diverting some Atrai flows down the Punarbhaba.

However, although the 20-yr discharge exceeds conveyance capacity the duration of exceedance is a few days, resulting in rather small crop damage. In view of this and the adverse affect of increasing cross-border flows it is suggested that no measures are urgently required except town protection works for Dinajpur being dealt with under FAP-9A.

No changes are proposed in the facilities designed to be provided under the Atrai-Kakra project.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KHANSAMA
SAIDPUR
TARAGANJ
KAHAROL
CHIRIBANDAR
PARBATIPUR
BADARGANJ
DINAJPUR
BIRAL
RIGHT FCD
ATRAI KAKRAJ FCD
PUNARBHABA LEFT FCD
PHULBARI
NAWABGANJ
BIRAMPUR
HAKIMPUR
PHULBARI
JOYPURHAT
TO RANGPUR
TO RANGPUR
TO GOBINDAGANJ
TEESTA RIVER
LEGEND :
International Boundary
District Boundary
Upazila Boundary
District H/Q
Upazila H/Q
Road
Earthen Road
Railway Line
Embankment Exist.
Embankment Prop.
Planning unit Boundary
River
NORTH WEST REGIONAL STUDY
UPPER ATRAI
PLANNING UNIT – 2

PLANNING UNIT 3

TEESTA RIGHT BANK

3.1 Basic Data

This planning unit consists parts of Nilphamari and Rangpur districts and Kaliganj and Lalmonirhat thanas from Lalmonirhat district. The eastern boundary of the unit is the Teesta river and the Kaliganj-Pirgacha railway. The west boundary is the Ghaghot river, the Mohadebpur-Jaldhaka road and the Buri Teesta river.

Basic data of the planning unit is presented in Table 3.1. The gross area is 132000 ha.

The population in 1981 was 0.95 million. Population densities are a little above the average for the region at 7.18 per ha gross.

High population densities are found in the partly-urbanised thanas of Kaunia and Rangpur.

3.2 Agriculture

3.2.1 Soils

The planning unit lies within the Teesta Flood Plain Physiographic unit.

3.2.2 Cropping Patterns

Almost all land in the planning unit is highland or medium-highland and therefore cropping patterns are not severely constrained by floods.

Overall cropping intensity in the planning unit is about 152%, and irrigation coverage is 14% of NCA. In the rabi/boro season the area of wheat and HYV boro cultivation is about the same, and in the aman season HYV t.aman is considerably more widespread than local t.aman.

Cropping patterns for the planning unit are shows in Table 3.2.

3.2.3 Crop Damage

Crop damage due to flooding is not significant in normal years. In high flood years damage results mostly due to spillage from the Teesta through the right embankment. In 1987 about 25% of the planted area of t.aman was fully damaged, and in 1991 the corresponding figure was about 19%. Damage is relatively more severe in the south of the planning unit, in Rangpur and Pirgacha thanas.

Table 3.1 Planning Unit 3 Basic Data

Thana	Percentage in Planning Unit	Percentage in Thana
RANGPUR	13	54
PIRGACHA	9	44
KAUNIA	8	66
SUNDARGANJ	1	3
KALIGANJ	4	19
JALDHAKA	9	36
MITHAPUKUR	tr	0
KISHOREGANJ	10	49
PATGRAM	tr	1
HATIBANDHA	7	32
LALMONIRHAT	1	3
GANGACHARA	13	89
DOMAR	tr	1
DIMLA	25	99

Gross Area (ha) : 131732
Nca Area (ha) : 115592

Total population (1981) : 945388 Population Density : 7.18
(per ha Gross area)

Flood Phase :

F0 (ha) :	40006	F0 % of NCA (ha) :	35
F1 (ha) :	74985	F1 % of NCA (ha) :	65
F2 (ha) :	584	F2 % of NCA (ha) :	1
F3 (ha) :	15	F3 % of NCA (ha) :	0
F4 (ha) :	0	F4 % of NCA (ha) :	0

Irrigation Equipment Operating :

STW 81	106	STW 89	2816
DTW 81	92	DTW 89	224
LLP 81	104	LLP 89	78
Irrigation Coverage (%) Yr 81	3	Irrigation Coverage (%) Yr 89	14

TABLE 3.2 CROPPING PATTERN

LAND TYPE	MOUNT(HA)
F0	40006
F1	74985
TOTAL	114991
F2	584
F3	15
TOTAL	
F4	0
GTOYAL	115592

IRRIGATION BALANCE	
HYV BORO	14396
WHEAT	0
HYV AUS	1787
TOTAL	16183

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGATED AREA	NONIRRIGA AREA	TOTAL AREA	% IRRIG
F0	4525	35481	40006	11
F1	11248	63737	74985	15
TOTAL	15773	99218	114991	14
F2	409	175	584	70
F3	0	15	15	80
F4			0	
TOTAL	16182	99410	115592	

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	13987	B. AUS	30797	HYV TAMAN	59299	SUGARCAN	502
WHEAT	14766	HYV AUS	4371	L.T. AMAN	29802	ORCHARDS	38
POTATO	552	JUTE	16501	VEGETABLE	84		
TOBACCO	422	OILSEEED	261	SPICES	311		
PULSES	2308	SPICES	471				
OILSEED	530	VEGETABLE	279				
SPICES	471						
VEGETABLES	195						
Sub-Total	32565	Sub-Total	52680	Sub-Total	89185	Sub-Total	540
Total	174969						
CROPPING INTENSITY	152						

CROPS ON F2 LANDS

HYV BORO	409
DW AMAN	460
PULSES	0
L.BORO	103
Total	869
CROPPING INTENSITY	149

CROPS ON F3 LAND

HYV BORO	0
LOCAL BORO	15
D.W.AMAN	7
Total	22
CROPPING INTENSITY	147

Grand Total	175860
CROPPING INTENSITY	152

3.3 Fisheries

There are about 5500 ha of water areas in the planning unit, producing about 800 tonnes annually.

Fishing Sector	Area (ha)	Yield (KG/ha)	Production (mt)
Beels	294	450	132
Rivers	4000	89	356
Flood Plains	600	69	41
Total Capture Fish:	4894		529
Fish Ponds:			
- Cultured	203	950	193
- Culturable	130	450	59
- Derelict	264	120	32
Total Culture Fish:	602		284
Overall Total:	5496		813

The river fisheries have been very important in this area but are still declining from combined impacts of FCD and heavy fishing. RDRS, BRAC and CARE all support fishing groups taking over derelict ponds. CARE also supports interesting paddy and fish culture pilot trials.

3.4 Infrastructure

3.4.1 Major infrastructure and industries

The major infrastructure in the planning unit are the roads, railway line and a number of important structures. The important roads are Rangpur - Kurigram, Rangpur - Saidpur and Rangpur - Gangachara.

Rangpur town is situated in the planning unit and a number of important small scale industries are situated in the area.

There are two important barrages in the planning unit, namely the Teesta barrage and Buri Teesta Barrage, both of which are associated with a large number of FCDI infrastructures.

The Parbatipur-Kaunia railway traverses the planning unit from west to east. Tobacco is an important crop in the area, and there are many tobacco factories.

3.4.2 Damage to infrastructure and industries

In 1987 damage to BWDB infrastructure was Tk. 130 lac, and to LGEB infrastructure Tk. 31 lac. In the case of BWDB this damage was mainly along the Teesta Right Embankment but there was also some damage downstream on the Ghagot.

In 1988 there was no damage recorded by the Roads and Highways Department in Planning Unit 3. For BWDB the recorded damage was Tk. 428 lac, in locations similar to the previous year. For LGEB it was Tk. 315 lac, centred on Dimla in the north of the unit, Gangachara,. Rangpur and Pirgacha.

3.5 Special issues

FCD planning in this unit must take full account of the on-going Teesta Irrigation Project. This is discussed under Planning Unit 6. Environmental monitoring of the impacts of the barrage is desirable.

3.6 Hydrology and morphology

Major rivers

The Teesta and Buri Teesta are the major rivers in the planning unit.

The river Teesta is a braided river, with 2 or 3 distinct flowing channels and an average width of 4 to 5 km. It is well known for its unstable flowing course and continuous movement and scours, particularly during the flood seasons. The river originates in the very high Sikkim Himalayas in India, the elevation of which is around 8,000m above sea level. The river drains a catchment area of about 10,100 km^2, comprising land of Bangladesh and India. The Teesta river in its upper reaches is steep and swiftly flowing, collecting melting snow and glacier water as well as high rainfall in the catchment.

The river transports a large quantity of coarse sediment and debris from Himalaya. As a result, when it enters into piedmont terrain of Bangladesh, it starts depositing silt and becomes braided.

There are a number of important structures built on the Teesta. An irrigation barrage was constructed in India across the Teesta which was planned to divert about 4.25 cumecs in dry months so that little discharge would flow downstream in the drought periods. In Bangladesh also, a barrage has been constructed for the purpose of supplementary irrigation to the present prevailing irrigation system by STW.

Besides, the existing Kaunia railway bridge is situated across the Teesta. It appears from the river profile that the river at the Kaunia railway bridge has formed a very deep section which is almost the same as the outfall in terms of the river bed elevation, although it is situated 41.5 km upstream of the outfall. The river width at Kaunia is only 700 m, in spite of the normal river width being 4 to 5 km. Due to the movement of the sand bar, outfall of the Teesta is being seriously silted.

Hydrology

At present the Teesta river is gauged at Dalia, Doani, Kaliganj and Kaunia for water level and Kaunia Dalia-Doani for discharge. However long time data is available for Kaliganj and Kaunia only. The mean daily maximum WL of Teesta at Kaliganj and Kaunia and discharge at Kaunia are given in Table 3.3 and 3.4.

The rainfall data of Kaliganj for three high rainfall months are given in Table 3.5 as a representative station.

Table 3.3 Max Mean Daily Discharges (m^3/s)

	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Kaunia	4298	6186	3590	5900	3190	7972	8710	6750	3651	4832	4010	4180

Table 3.4 Maximum Mean Daily Water Levels - Teesta (m PWD)

	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Kaunia	29.94	30.18	29.71	29.81	29.76	30.27	30.46	29.37	29.74	30.13	29.80	29.74
Kaliganj	40.17	40.87	40.48	40.43	40.06	40.84	41.08	40.42	40.04	40.81	40.76	40.43

Table 3.5 Kaliganj Rainfall (mm/month)

	July	August	September
1:2	530	408	393
1:20	992	912	669
1987	1094	727	532
1988	482	1170	537

Morphology

The Teesta originates from the foot hills of the Himalayas, the river bed slope of the river is relatively steep. The river slope is about 0.00068 in a 36 km long reach upstream of the Kaunia railway bridge and 0.00025 in the downstream reach from Kaunia bridge. The average width of the Teesta is 4 to 5 km, but the river section is quite irregular in terms of width. While, the river flow depth is about 2.5 to 3 m in bank full level. Since the river bed is very steep and flow velocity is as quite high as about 3.5 m/s, erosion activity along the right bank is very notable. At the Kaunia railway bridge, there is river training works for confirming the river flows within 0.7 km of the channel width. Due to this, the river is subject to deep scouring at that location. It may be mentioned that the newly constructed barrage at Doani is about 0.7 km long. These show that with river training the river can be confined to the considerably narrow section. The river bank is completely composed of non-cohesive soil. As such enormous erosion occurs in the river banks particularly on the right banks. On the other hand, there are some minor problem on the river bank erosion in the left bank.

The banks of the Teesta river are unstable and erosion occurs every year. In recent years, erosion on the right bank of the Teesta river is very prominent. Most of the thanas along the right bank of the Teesta river are affected by the flood water through the breaches which occurred due mainly to bank erosion. A study on river bank lines in different years based on aerial photographs and field survey indicates that in average, an area of 2030 acres (812 ha) have been eroded on the right bank between the year 1953 to 1967. The Teesta river changes its course almost every year forming various channels which in turn some times hit directly the bank causing erosion.

3.7 Existing FCD/I infrastructures

Teesta Right Embankment Project

Teesta right embankment project is a completed FCD scheme for protecting the right bank from flooding. The following are existing FCD infrastructures on the right embankment.

Embankment	: 26.4 km
Regulator	: 1 no

Bangladesh Water Development Board (BWDB) initiated a study on the Teesta embankment project in early 1968 for protection of agricultural lands and subsequently a feasibility study thereon was prepared in 1969. The security of the Teesta Right Embankment (TRE) and consequently the area protected by TRE have been seriously threatened by continued bank erosion. The Teesta river caused flooding over 20,000 ha of land on its right bank between Kaunia in the south and Indian Border in the north. After completion of the feasibility study, BWDB constructed the Teesta Right Embankment in 1970's. The Teesta Left Embankment was also constructed in 1975. The distance between these two embankments on both banks is about 4 to 6 km.

At present BWDB is constructing revetment works on the slope of river bank with heightening of the bank using sand cement block (0.30 m x 0.30 m x 0.30 m) at Godownerhat along the Teesta right embankment in Gangachara thana. The construction methods undertook in the location seems very effective and such types of bank protective works may also be suggested for the Teesta Left Bank.

Teesta Irrigation Project

This project is discussed under Planning Unit 6.

Buri Teesta Project

The scheme was initiated by BWDB as a pilot scheme for the Teesta Project, and the project was completed in 1964. The Buri Teesta barrage at Jaldhaka is diverting flows for supplementary irrigation purposes through the canal system.

3.8 Flooding and Drainage in the Planning Unit

The GIS data indicates thus there is practically no F2-F4 land in the planning unit so that prolonged and serious flooding is not a general problem. Cropping intensities are about the regional average, and there is a high proportion of HYV t.aman.

Hydrodynamic modelling and evidence from the field confirms that spills from the Teesta contribute to flows in the Ghagot and Karatoya and flooding downstream on those rivers. Infrastructure damage tends to be severe along the Teesta, which is to be expected in view of the high cost of the infrastructure there. It is also high along the Ghagot.

3.9 Options for Development

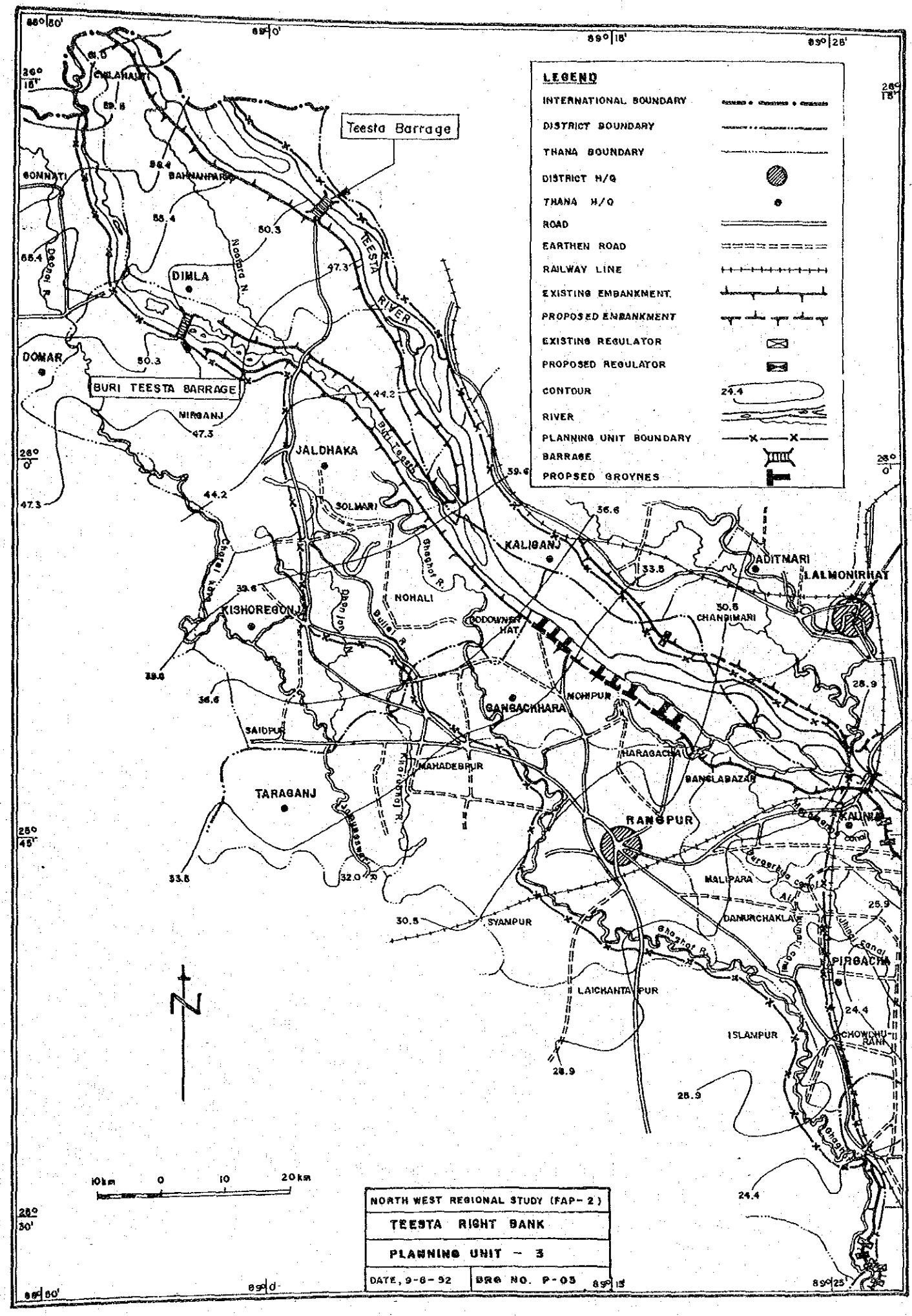
Flood control measures on the Teesta are a relatively high priority because of the contribution of Teesta spills to flooding and damage downstream. These may take the form of strengthening and rehabilitation of the existing embankment, embankment retirement or river training works.

Modelling results indicate that this would cause a significant reduction in damage and human discomfort along the Teesta as well as reducing downstream discharges in the Ghaghot. Impacts of the increased discharges on the Brahmaputra, on the other hand, would not be significant.

There is a need to strengthen the Teesta Right Embankment at several locations from downstream of the Teesta barrage to Kaunia. This is particularly the case at Godownerhat and Mohipur, where serious erosion is taking place, and in the Solmari-Noahali-Paikan reach, where breaches have already occurred and damage to monsoon crops resulted. River bank protection works are proposed at these locations, together with the construction of a retired embankment at Solmari-Noahali-Paikan.

The existing embankment between Teesta Barrage and Kaunia of Teesta river also require to be strengthened. Since the embankment with a height of around 4m on an average is of sandy soil obtainable from the region, it is threatened by erosion even in the normal flood. Hence, the existing embankment itself needs to be strengthened. In reforming the existing embankment, it is proposed that a berm is provided on both sides at an interval of 3m in height to be structurally strengthen. Moreover, a borrow area for obtaining embankment material needs small cross bars in the flood plain level to stop flow during monsoon which ultimately develops as branch channel of the Teesta so that those would cause erosion sometimes.

Analysis of satellite imagery indicates that the Teesta outfall has moved north since 1977 due to erosion by the main river. Erosion is still continuing in this location and the embankment at Chilmari has been retired.


LEGEND
INTERNATIONAL BOUNDARY
DISTRICT BOUNDARY
THANA BOUNDARY
DISTRICT H/Q
THANA H/Q
ROAD
EARTHEN ROAD
RAILWAY LINE
EXISTING EMBANKMENT
PROPOSED EMBANKMENT
EXISTING REGULATOR
PROPOSED REGULATOR
CONTOUR
RIVER
PLANNING UNIT BOUNDARY
BARRAGE
PROPSED GROYNES
Teesta Barrage
BURI TEESTA BARRAGE
TEESTA RIVER
DIMLA
DOMAR
JALDHAKA
NIRGANJ
SOLMARI
KISHOREGONJ
NOHALI
KALIGANJ
ADITMARI
LALMONIRHAT
CHANDMARI
GODOWNER HAT
GANGACHHARA
MOHIPUR
SAIDPUR
HARAGACHA
MAHADEBPUR
TARAGANJ
BANGLABAZAR
RANGPUR
KALINA
MALIPARA
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SYAMPUR
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NORTH WEST REGIONAL STUDY (FAP-2)
TEESTA RIGHT BANK
PLANNING UNIT - 3
DATE, 9-8-92
DRG NO. P-05