TABLE.10.18 ESTIMATION OF LAND ENHANCEMENT BENEFIT

(A). AGRO-ECONOMIC INDICATORS by KECAMATAN RELATING TO RETARDING BASINS

		KEC.JATIKALEN	KEC.SUKOMORO + KEC.GONDANG	KEC.TANJUNGANOM + KEC.SUKOMORO
1. AVERAGE UNIT YIELD OF PADDY	(ton/ha)	4.47	4.64	4.74
2. AVERAGE UNIT YIELD OF MAIZE	(ton/ha)	2.21	2.58	3.23
3. AVERAGE UNIT YIELD OF SOYBEAN	(Ton/ha)	.76	.91	.8
4. AVERAGE UNIT YIELD OF PADDY FIELD per-FARM HOUSE	(ha/house)	.37	.59	.44

(B). AGRO-ECONOMIC INDICATORS OF RETARDING BASINS

		WIDAS	ULO	KEDUNGSOKO
1. AVERAGE UNIT YIELD OF PADDY	(ton/ha)	3.91	4.82	4.64
2. AVERAGE UNIT YIELD OF MAIZE	(ton/ha)	1.89	2.34	2.84
3. AVERAGE UNIT YIELD OF SOYBEAN	(ton/ha)	-	.67	.81
4. NO of FARM HOUSE		632	1228	2515
5. AVERAGE CROPPING PATTERN *		Pa-Pa-Polo	Pa-Pa-Polo	Pa-Pa-Polo

* Pa - Paddy * Polo - Polowijo

(C). THE DIFFERENCE OF UNIT YIELD by CROPS BETWEEN (A) and (B)

PADDY	(ton/ha)	.56	-.18	.1
MAIZE	(ton/ha)	.32	.24	.39
SOYBEAN	(ton/ha)	-	.24	-.01

(D). ECONOMIC PRICE OF CROPS PRESENT (1985 PRICE)

		PADDY	MAIZE	SOYBEAN
	(Rp/ton)	143142	185660	338560

(E). INCREMENTAL BENEFIT OF CROPS per ha

		WIDAS	ULO	KEDUNGSOKO
PADDY	(Rp./ha)	80159	-	14314
MAIZE	(Rp./ha)	59411	44558	72407
SOYBEAN	(Rp./ha)	-	81254	-

(F). INCREMENTAL BENEFIT BASED ON CROPPING PATTERN

	(Rp./ha)	219730	62910	101040

(G). CONTROLLABLE AREA (5 - YEARS RETURN PERIOD)

	(ha)	200	210	780

(H). INCREMENTAL BENEFIT (F)x(G)x0.9 (10^6 Rp.)	39.6	11.9	70.9

TOTAL 122.4 x 10^6 Rp.

Table 10.19 INUNDATION VOLUME, AREA AND WATER LEVEL

Retarding Basin			Return Period (Year				
			1.05	2	5	10	25
(1) Under present Condition							
Widas	Volume	(m^6m^3)	9.1	10.8	12.4	14.3	15.9
	Area	(km^2)	11.3	12.8	14.3	16.6	18.6
	W.L	(EL.m)	38.12	38.26	38.39	38.54	38.66
Ulo	Volume	($10^6/m^3$)	6.2	7.0	8.5	9.8	11.8
	Area	(km^2)	6.6	6.9	7.1	7.1	7.1
	W.L.	(EL.m)	44.73	44.86	45.0	45.0	45.0
Kedungsoko	Volume	($10^6/m^3$)	8.2	9.3	10.7	11.7	14.1
	Area	(km^2)	10.8	11.7	12.7	13.6	15.3
	W.L.	(El.m)	44.89	45.00	45.11	45.21	45.39
(2) 1st stage							
Widas	Volume	(10^6m^3)	5.54	8.76	10.66	11.55	-
	Area	(km^2)	9.15	11.15	12.08	12.45	-
	W.L.	(EL.m)	37.82	38.16	38.34	38.42	-
Ulo	Volume	(10^6m^3)	0	1.55	3.21	4.73	-
	Area	(km^2)	0	4.20	5.75	6.25	-
	W.L.	(EL.m)	0	43.67	44.	44.35	-
Kedungsoko	Volume	(10^6m^3)	1.77	2.71	3.82	4.63	-
	Area	(km^2)	3.35	4.25	5.30	6.05	-
	W.L.	(EL.m)	44.03	44.22	44.40	44.52	-
(3) 2nd stage							
Widas	Volume	(10^6m^3)	5.54	8.89	10.95	12.22	13.57
	Area	(km^2)	9.0	11.25	12.25	12.70	13.20
	W.L.	(EL. m)	37.82	38.18	38.37	38.47	38.57
Ulo	Volume	(10^6m^3)	0	0.71	2.12	3.40	4.78
	Area	(km^2)	0	2.20	4.90	5.80	6.30
	W.L.	(EL.m)	0	43.33	43.82	44.11	44.36
Kedungsoko	Volume	(10^6m^3)	1.51	2.34	3.40	4.18	5.12
	Area	(km^2)	3.20	3.90	4.85	5.60	6.50
	W.L.	(EL. m)	43.98	44.15	44.33	44.45	44.59

Note : Retarding Volume in Kedungsoko and Widas retarding basin includes dead volume of 1.0×10^6 m^3 and 4×10^6 m^3 respectively.

Table 10.20 DISBURSEMENT SCHEDULE OF FLOOD CONTROL PLAN (ECONOMIC COST)

Unit: RP. 10^6

Year	Direct Cost		Land acquisition and House		Administration		Engineering Service		Base Cost	Physical Contigency/4	O & M Cost/1	Replacement Cost	Total
	FC	DC	FC	DC	FC	DC	FC	DC	Total	Total			
1988				13.0					13.0	2.0			15.0
1989	1,497.2	1,142.1		176.0		207.1	265.0	66.3	3,353.7	503.1			3,856.8
1990	3,817.3	3,021.9		352.0		414.1	530.1	132.5	8,267.9	1,240.2			9,508.1
1991	5,431.8	4,285.9		528.0		414.1	530.1	132.5	11,322.4	1,698.4			13,020.8
1992	5,009.8	3,829.3		704.0		414.1	530.1	132.5	10,619.8	1,592.9			12,212.7
1993	2,638.4	2,130.8		880.0		414.1	530.1	132.5	6,725.9	1,008.9			7,734.8
1994	740.4	607.1		1,056.0		270.1	265.0	66.3	2,941.9	441.3			3,383.2
1995				1,056.0							170.8		1,226.8
1996				1,056.0							170.8		1,226.8
1997				1,056.0							170.8		1,226.8
1998				1,056.0							170.8	-3,751.6/3	-2,524.8
1999 - 2017				1,056.0							170.8		1,226.8
2018				1,056.0							170.8	426.2/2	1,653.0
2022 - 2044				1,056.0							170.8		1,226.8

Note: /1 Operation and maintenance cost = 0.5% of direct cost

/2 Replacement cost = cost of metal works

/3 -3,751.6 x Rp. 10^6 = the portion of bridge and structures relating to rivers, which would be incurred by local government

/4 Physical contingency = 15% of Base Cost

Table 10.21 CASH FLOW AND IRR (1985 LEVEL)

Unit: 10^6 Rp.

No.	Year	Capital Cost	Replacement Cost	O&M Cost	Total Cost	Benefit
1	1988	15.0	0	0	15	
2	1989	3,856.8	0	0	3,856.8	
3	1990	9,508.1	0	0	9,517.1	
4	1991	13,020.8	0	0	13,020.8	
5	1992	12,212.7	0	0	12,212.7	
6	1993	7,734.8	0	0	7,734.8	
7	1994	3,383.2	0	0	3,383.2	
8	1995	0	0	170.8	170.8	6,236.2
9	1996	0	0	170.8	170.8	6,236.2
10	1997	0	0	170.8	170.8	6,236.2
11	1998	0	-3,751.6	170.8	-3,580.8	6,236.2
12-30	1999-2017	0	0	170.8	170.8	6,236.2
31	2018	0	426.2	170.8	597.0	6,236.2
32-57	2019-2044	0	0	170.8	170.8	6,236.2

IRR = 9.8%

Table 10.21 CASH FLOW AND IRR (FUTURE LEVEL)

Unit: 10^6 Rp.

No.	Year	Capital Cost	Replacement Cost	O&M Cost	Total Cost	Benefit
1	1988	15			15	
2	1989	3,856.8			3,856.8	
3	1990	9,508.1			9,508.1	
4	1991	13,020.8			13,020.8	
5	1992	12,212.7			12,212.7	
6	1993	7,734.8			7,734.8	
7	1994	3,383.2			3,383.2	
8	1995			170.8	170.8	8,456.1
9	1996			170.8	170.8	8,633.9
10	1997			170.8	170.8	8,815.3
11	1998		-3,751.6	170.8	-3,580.8	9,000.2
12	1999			170.8	170.8	9,188.8
13	2000			170.8	170.8	9,381.1
14	2001			170.8	170.8	9,577.1
15	2002			170.8	170.8	9,776.5
16	2003			170.8	170.8	9,979.7
17	2004			170.8	170.8	10,186.9
18	2005			170.8	170.8	10,398.2
19	2006			170.8	170.8	10,613.7
20	2007			170.8	170.8	10,833.4
21	2008			170.8	170.8	11,057.4
22	2009			170.8	170.8	11,285.9
23	2010			170.8	170.8	11,518.9
24	2011			170.8	170.8	11,756.4
25	2012			170.8	170.8	11,988.4
26	2013			170.8	170.8	12,219.2
27	2014			170.8	170.8	12,454.7
28	2015			170.8	170.8	12,695.0
29	2016			170.8	170.8	12,940.2
30	2017			170.8	170.8	13,190.4
31	2018		426.2	170.8	597.0	13,445.7
32	2019			170.8	170.8	13,706.2
33	2020			170.8	170.8	13,972.0
34	2021			170.8	170.8	14,236.9
35	2022			170.8	170.8	14,507.3
36	2023			170.8	170.8	14,783.3
37	2024			170.8	170.8	15,065.1
38	2025			170.8	170.8	15,352.7
39	2026			170.8	170.8	15,646.3
40	2027			170.8	170.8	15,946.0
41	2028			170.8	170.8	16,252.0
42	2029			170.8	170.8	16,564.2
43	2030			170.8	170.8	16,883.0
44	2031			170.8	170.8	17,208.3
45	2032			170.8	170.8	17,540.4
46	2033			170.8	170.8	17,879.4
47	2034			170.8	170.8	18,225.4
48	2035			170.8	170.8	18,578.6
49	2036			170.8	170.8	18,939.1
50	2037			170.8	170.8	19,307.0
51	2038			170.8	170.8	19,682.5
52	2039			170.8	170.8	20,065.8
53	2040			170.8	170.8	20,457.0
54	2041			170.8	170.8	20,856.3
55	2042			170.8	170.8	21,263.8
56	2043			170.8	170.8	21,679.8
57	2044			170.8	170.8	22,104.3

IRR = 14.1%

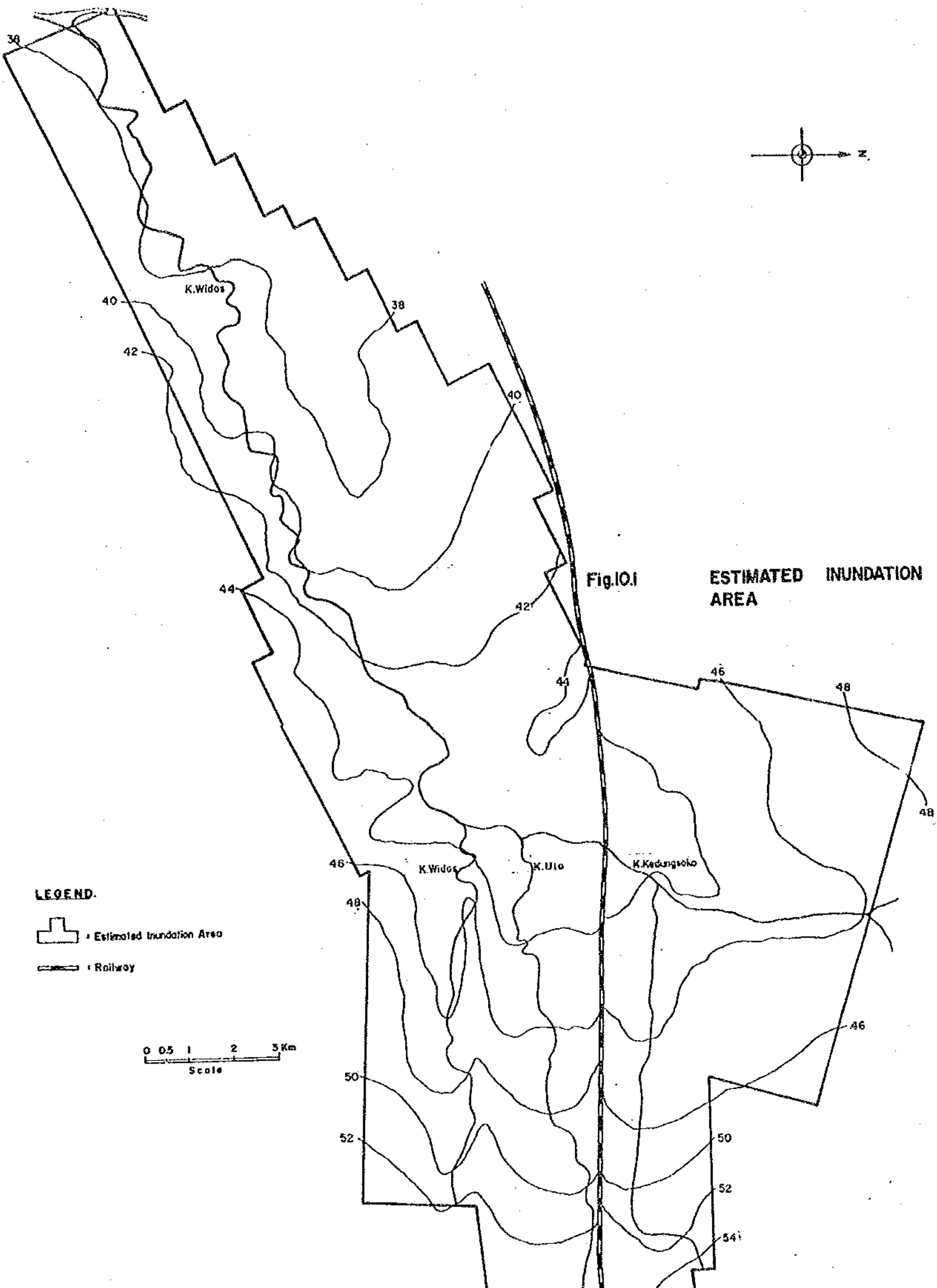


Fig.10.1
ESTIMATED INUNDATION AREA
LEGEND.
: Estimated Inundation Area
: Railway
0 0.5 1 2 3 Km
Scale
K.Widas
K.Widas
K.Ulo
K.Kedungsoko
38
38
40
40
42
42
44
44
46
46
46
48
48
48
50
50
52
52
54
54

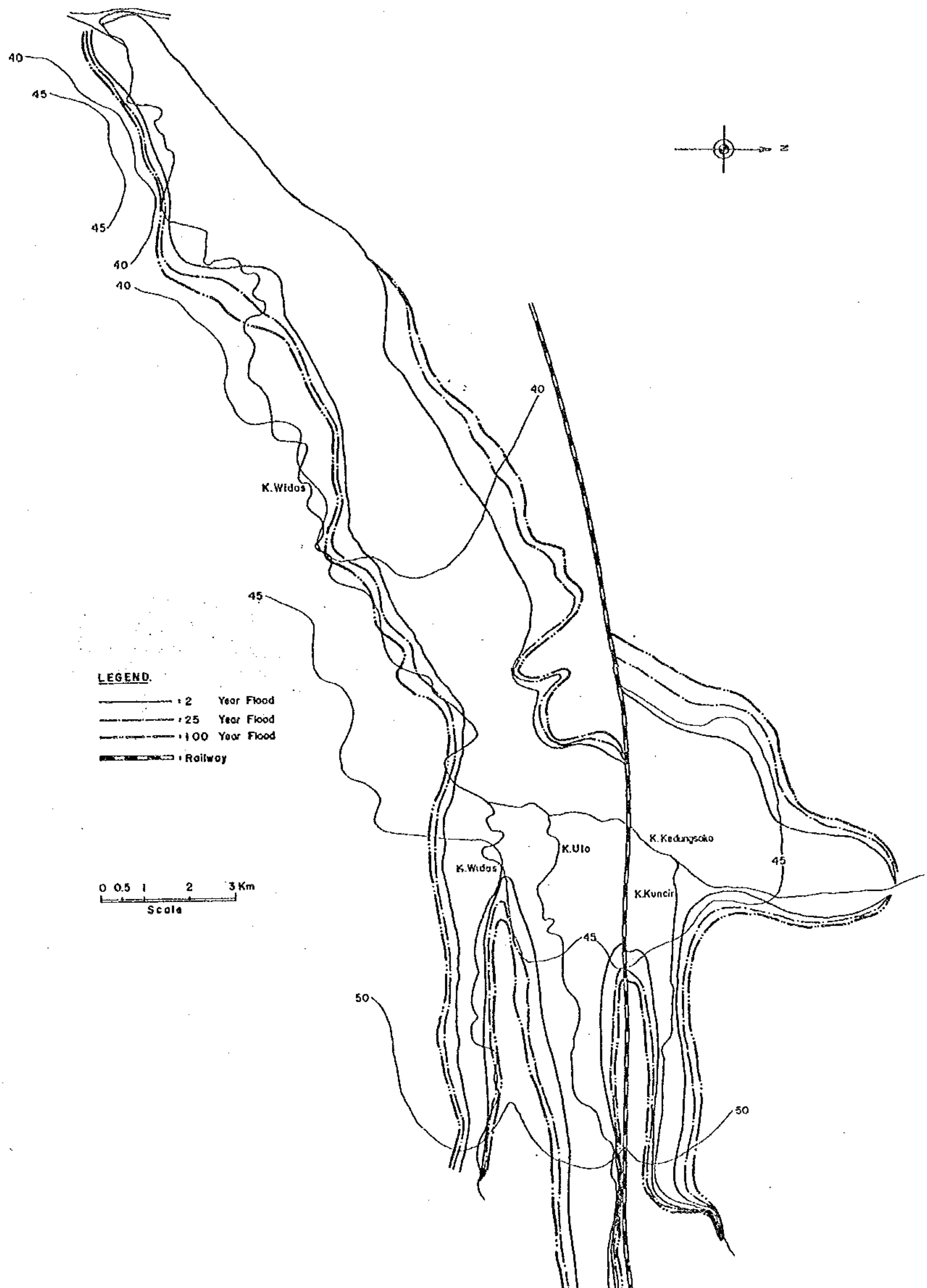
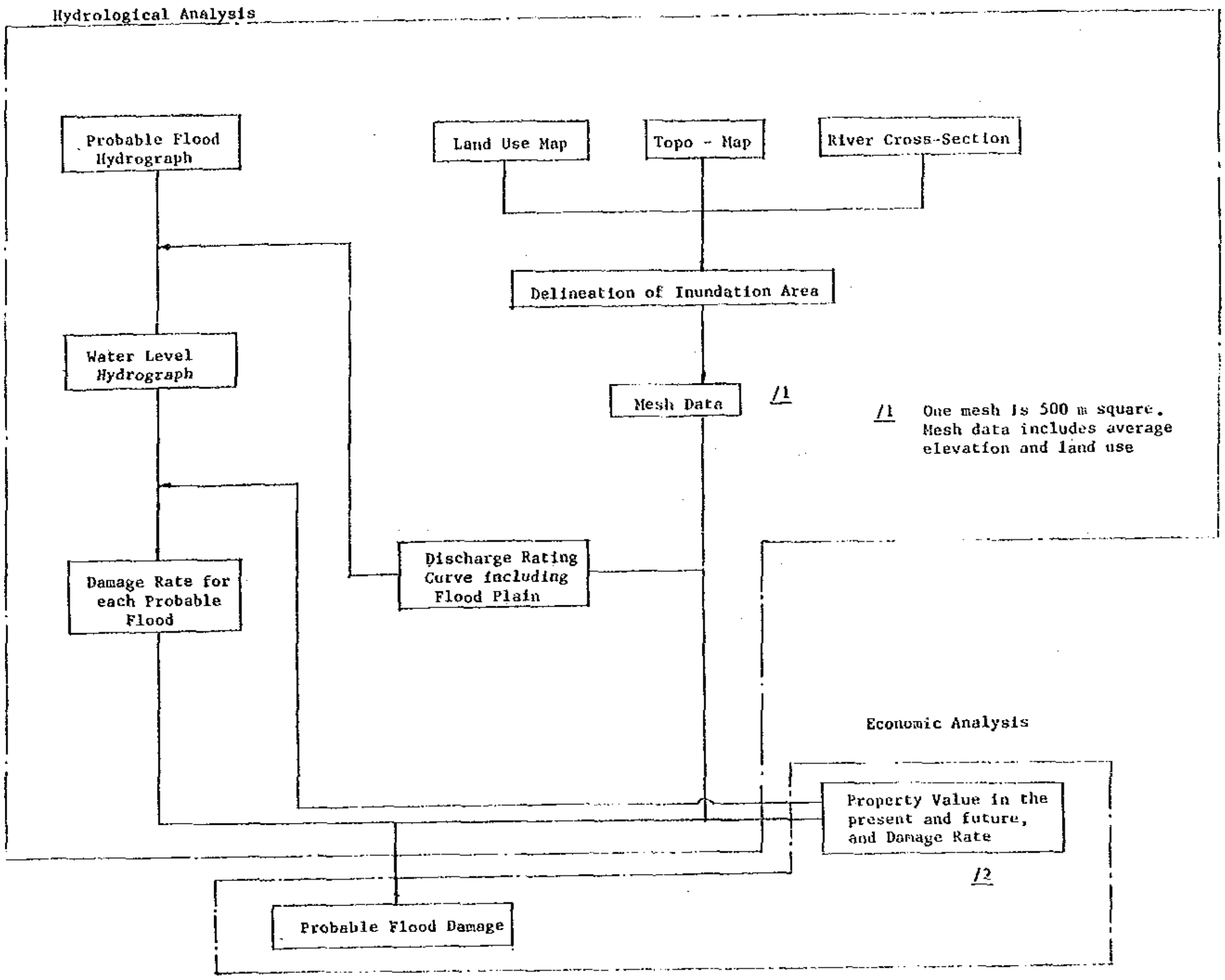


Fig. 10.1 ESTIMATED INUNDATION AREA DUE TO PROBABLE FLOOD



/2 Damage rate for property is determined from inundation depth and duration

Fig. 10.2 GENERAL PROCEDURE FOR FLOOD DAMAGE ANALYSIS

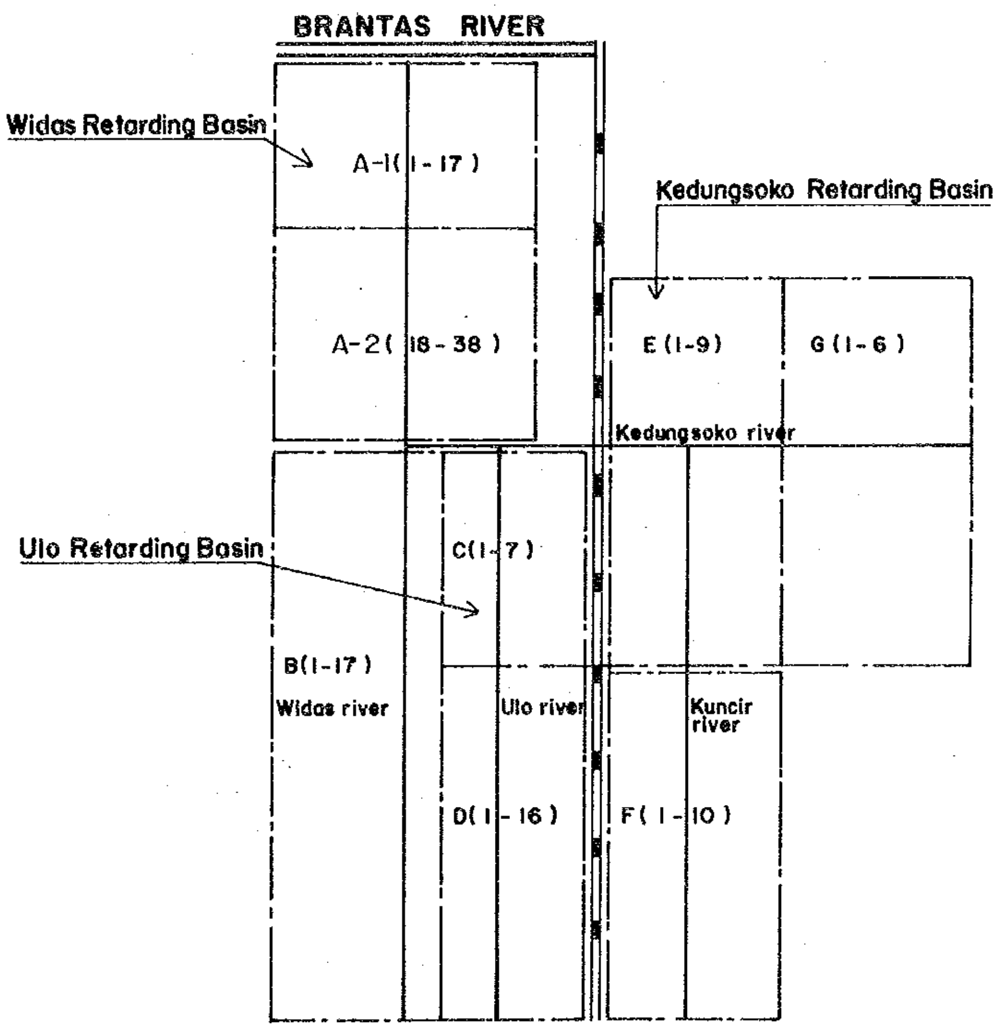
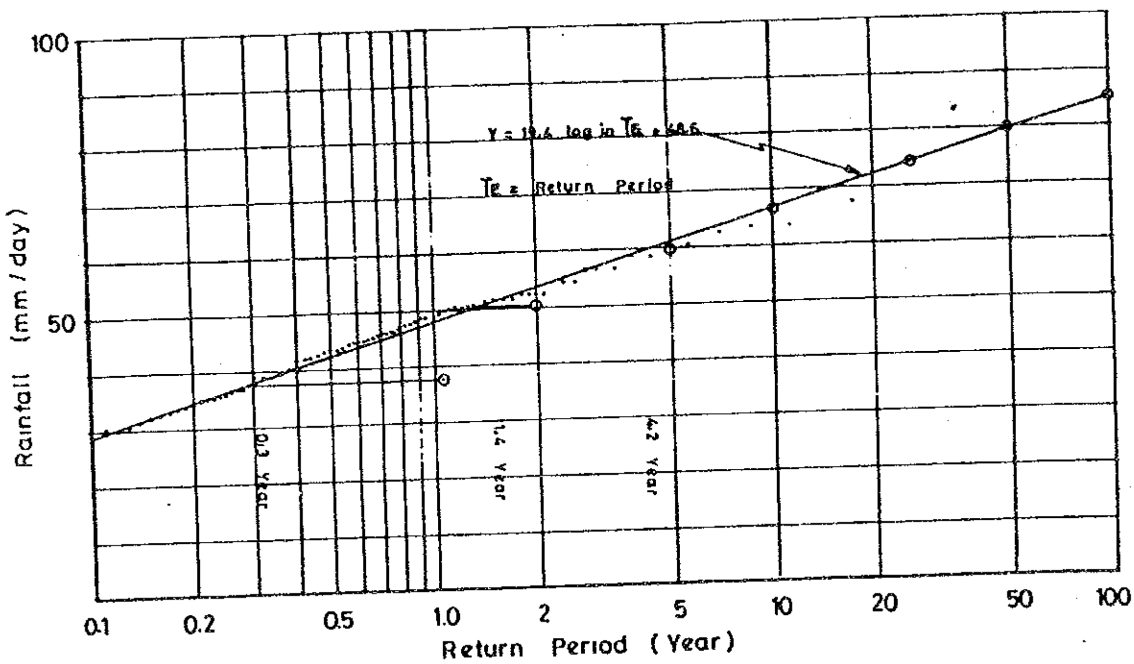


Fig. 10.3 BLOCKS FOR FLOOD DAMAGE ESTIMATION

Probable Rainfall.		
Return Period	Annual Max.	Non Annual Exc.
0.2	—	35
0.5	—	41
1.0	—	49
1.05	38	49
2	51	55
5	60	63
10	67	68
25	75	76
50	81	82
100	87	88

Unit : mm



• Non Annual Exceedance Series More than 30 mm / day

o Probable Rainfall by Gumbel's Method, Annual Maximum Series

Fig.10.4 FREQUENCY CURVE BY EXPONENTIAL DISTRIBUTION.

PART III DAM AND IRRIGATION

LIST OF FIGURE

11. INTRODUCTION

In the PART I Study, irrigation development was studied from the viewpoint of regional equity of development by using the cropping intensity of paddy as a measuring scale of equity, as the result, the northeastern part of the Widas river basin (hereinafter called as "Widas Extension Area") was found one of the less-developed area in the Widas river basin.

For development of the Widas Extension Area, a storage reservoir on the Kedungwarak river and irrigation development over an area of 950 ha was conceived. However, this plan can not solve the regional inequity problem in the western half of the Widas Extension Area.

In this feasibility study, another reservoir site on the Ketandan river is found. By exploitation of this reservoir site, almost all the farm lands in the Widas Extension Area can become commanding area of the dam and irrigation development project. Also from the view point of regional equity, the irrigation development in the area around the Kedungwarak reservoir, so-called, Ngluyu area is conceived through the comparative alternative Study. Fig. 11.1 shows the location of Widas Extension Area.

To this end, the total objective farm land and irrigation areas become as follows;

	Objective Farm Land (Ha)	Irrigation Area with Project (Ha)
Ngluyu	128	122
Lengkong	1,398	1,328
Tretes	1,584	1,505
Total	3,110	2,955

* Out of the objective area, 5% is assumed to be occupied by irrigation and drainage facilities.

The project area covers the following desas;

Kecamatan Ngluyu	:	Ngluyu
Kecamatan Gondang	:	Balonggebang, Nguyung, Ketawang, Sumberagung, Kedungglugu and Jaan.
Kecamatan Lengkong	:	Lengkong, Jatipunggun, Jegreg, Ngringin, Ketandan, Sumberkepuh, Prayungan, Sumbersono, Sawahan and Banjardowo.

In case of compilation of some statistical data, desa Ngluyu is excluded since the project can cover only a small portion of desa Ngluyu.

Chapter 12 presents descriptions of present agriculture and irrigation conditions, including assessment of water resources in the entire Widas river basin for clarification of water situation. Chapter 13 presents proposed agricultural development from the view point of equitable development. Chapter 14 presents river runoff estimate. Chapter 15 presents methodology and results of unit diversion requirement estimation. Chapter 16 presents conditions and results of comparative study of alternatives. Chapter 17 describes the proposed and irrigation development plan, with justification. Chapter 18 presents construction plan and schedule for the proposed plan. Finally, evaluation of the proposed plan is presented in Chatper 19. Chapter 20 presents operation and maintenance plan.

As explained in Chapter 2, two projects are in progress in the Widas Extension Area. One is the East Java Irrigation Rehabilitation project (EJIP) and the other is the East Java Groundwater project (EJGP).

EJIP is now preparing detailed designs for rehabilitation of DI Ketandan and DI Jurang Dandang. According to information, implementation of the rehabilitation is scheduled in 1988. Contacts with EJIP were made, and it is confirmed that the irrigation facilities after rehabilitation can be incorporated into the proposed irrigation system in this report without double investment.

EJGP drilled 10 tubewells of which 4 tubewells are under operation and 6 tubewells are waiting for pumps. There is one village-owned tubewell other than EJGP's. The total command area is 448 ha. In this report, it is assumed that the tubewell areas have their own water sources and does not need water from the proposed irrigation system. Then, the tubewell areas are excluded from the water requirement estimation and also fro, the benefit calculation. However, after completion of the proposed irrigation system, combined use of the surface water and groundwater shall be made. To make the combined use possible, it is necessary to solve an administrative problem of sharing the pumping cost among farmers.

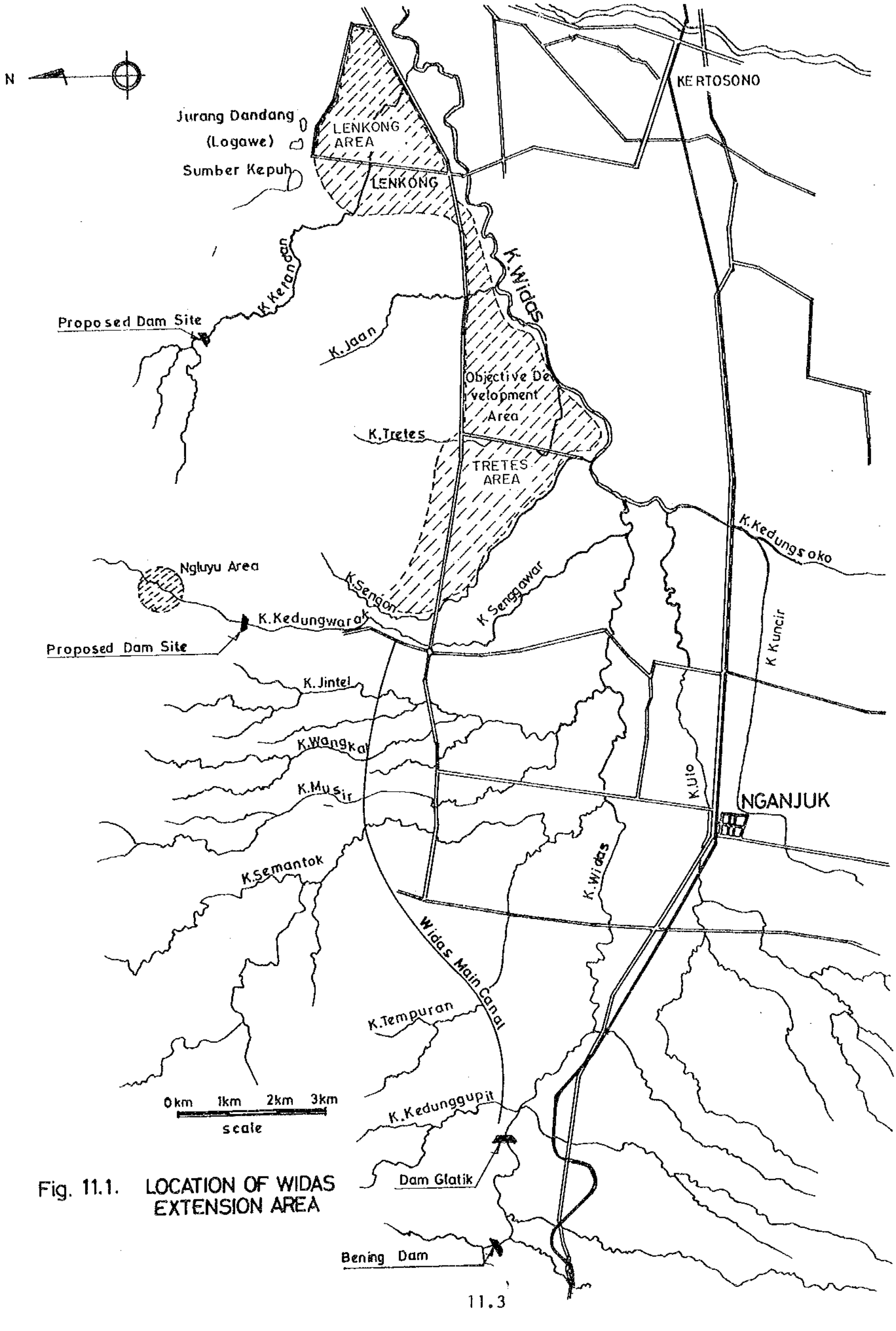


Fig. 11.1. LOCATION OF WIDAS EXTENSION AREA

CHAPTER 12 PRESENT AGRICULTURE AND IRRIGATION

LIST OF TABLES

LIST OF FIGURES

12. PRESENT AGRICULTURE AND IRRIGATION

12.1 General

In this Chapter, the present agriculture conditions in the Widas Extension Area are described. Descriptions cover the physical environment of the agriculture, farming practice and farm input, crop yield and production, land holding size and land tenure system, marketing and agriculture supporting system and farm economy under the present condition. Detailed data are presented in ANNEX-6.

The irrigation condition in the Widas Extension Area are described in comparison with those in other areas in the Widas basin, in order to clarify the situation of the Widas Extension Area.

12.2 Population and Economic Activities

The population in the Widas Extension Area was 45,487 persons in 1980, according to the census results. It was about 4.4% of the total population in the Widas basin. The average population density was 403 persons per km^2 ranging from 147 persons/km^2 in Desa Sumberkepuh to 1,398 persons/km^2 in Desa Sawahan. It was much lower than that of the Widas basin (of 705 person per km^2).

The economy of the Widas Extension Area depends primarily on the agricultural sector. The population engaged in this sector was about 15,800 persons in 1980 or around 90% of the total labour force. It consists of 12,055 farmers and 3,776 farm labourers without land.

Desa level data relating to the above are presented in the ANNEX-6.

12.3 Physical Environment of Agriculture

12.3.1 Climate

The climate in Widas Extension Area belongs to the tropical monsoon zone. The climate condition is as shown in Table 15.1. From the viewpoint of climate, there is no constraint, except rainfall distribution to grow almost all the tropical crops, since the sunshine hour is sufficient and the air temperature is high. Rainfall concentrates during the rainy season. In the dry season, crop like paddy cannot grow well without irrigation.

12.3.2 Water quality

In order to evaluate water quality for irrigation use, twenty one water samples were collected from rivers, streams and wells in the Widas Extension Area. The samples were analyzed in the Department of Soil Science, Faculty of Brawijaya University.

The results indicate that these waters in the Widas Extension Area are categories of C1-S1, C2-S1 and C3-S1 based on classification of irrigation waters (Agriculture Handbook 60) defined by the United States Department of Agriculture. And the results also suggest that these waters are within safe limits for irrigation use, as shown in ANNEX-6.

12.3.3 Soil and land capability

Soil and land capability survey and test was carried out by the Brawijaya University, covering the area of about 9,100 ha consisting of 1,600 ha in the Lengkong area and 7,500 ha in the Tretes area. Procedure of survey and details of soil classification and land capability are presented in ANNEX-6.

1. Soil Classification

For classification of the soils in the Widas Extension Area, the soil classification of the soil Taxonomy prepared by the United States Department of Agriculture is applied. Soil in the surveyed area are broadly classified into Vertisols, Inceptisols and Entisols in order basis. Features of these soils are presented in ANNEX-6, based on Soil Taxonomy (USDA Agriculture Handbook No. 436).

Soils in the survey area are further divided into 6 classes in sub-order basis, into 7 classes in Great group, into 7 classes in Sub-group. For convenience use for agriculture and irrigation study, 16 soil mapping units in the Tretes area and 10 soil mapping unit are taken with soil series and soil associations. Characteristics and area of each mapping unit are presented in Tables 12.1 and 12.2. Aerial distributions of mapping units are as shown on Figs. 12.1 and 12.2.

2. Land Capability

For classification of land capability in the Widas Extension Area, the Japanese land classification standard for paddy is applied, since the Japanese standard is devised originally for paddy cultivation, and its classification criteria are detailed enough for assessment of land capability on a feasibility study level. In the Japanese system, there are 13 factors for assessment of land capability as shown below;

1. thickness of top soil
2. effective soil depth
3. gravel contents in top soil
4. ease of plowing
5. permeability under submerged condition
6. state of redox potentiality
7. wetness of land (factors for upland crop only)
8. inherent fertility

9. content of available nutrient

10. degree of hazard

11. frequency of hazard

12. slope (factors for upland crop only)

13. erosion

Rating standards for each factor are presented in ANNEX-6.

The results of land capability study are as shown on Figs. 12.1 and 12.2 and summarized below.

In the survey area of both Tretes and Lengkong districts, the productive capability consists of mostly class II for paddy. Some limiting factors encountered are content of nutrients (n), easiness of plowing (P) and frequency of accident (flood).

For polowijo crops, the productive capability of the land are regarded as Classes III and II. The limiting factors are wetness of land, easiness of plowing and content of nutrient. The limited factors of wetness of land and easiness of land and easiness of plowing are improved by application of irrigation.

12.4 Present Land Use, Holding Size and Tenure System

12.4.1 Present land use

Land use in the villages related to the Widas Extension Area was examined by (i) land use information supplied from Kecamatan offices, (ii) interpretation of topographic maps on a scale of 1 to 2,500 and (iii) interpretation of aerial photos. Further the land use was checked by field reconnaissance survey.

The lands in the Widas Extension Area are classified into 6 categories, comprising paddy field, upland field, house yard, settlement, forest and others including road, river, etc. The present land use is presented in Table 12.3 and is summarized below.

	Area (ha)	Proportional Extent (%)
Paddy field	2,972	27.1
Upland field	675	6.2
House yard	293	2.7
Settlement	412	3.8
Forest	6,361	58.0
Others	241	2.2
Total	10,954	100.00

The farm land comprising paddy field and upland field amounts to about 3,647 ha or 33% of total project area. The paddy fields consists of (i) 2,758 ha of irrigated area of four Irrigation Units and (ii) 214 ha of rainfed paddy field.

Upland field is located in the predominant area of Mt. Kedungridge enclosed with forest in upper part and paddy field in the lower part. Settlement and house yard scatters mainly in the flat plain.

12.4.2 Land holding size and tenure system

According to statistical data, the average land holding size of farm land in 1983 is estimated at 0.45 ha, consisting of 0.36 ha of paddy field and 0.09 ha of upland field. Data of 8 desas within the Widas Extension Area shows the following distributions;

	No. of Tenure	%
Less than 0.25 ha	709	27.9
0.26 - 0.50	834	32.8
0.51 - 0.75	533	20.8
0.76 - 1.00	170	6.7
1.01 - 1.50	173	6.8
1.51 - 2.00	72	2.8
2.01 - 2.50	27	1.1
More than 2.51	27	1.1
Total	2,545	100.0

Data of two desas shows that 61% of farmer operates their own farms, 24% operates both own farms and rented farms, and 15% operates only rented farms. The land tenure system is based on either cash rent or share cropping system. The rate of cash rent prevailing in the area is about Rp. 350,000/ha/year.

12.5 Farming Practice and Farm Inputs

12.5.1 Cropping pattern

The studies on present farming practice and farm inputs were carried out on the basis of (i) the results of farmer's interview survey, (ii) the data obtained from the Agricultural Service Office and (iii) data obtained from Irrigation Service Office in Nganjuk.

The main crops grown in the Widas Extension Area are paddy, tobacco, sugarcane and polowijo crops such as soybeans and maize. They are grown in the paddy field. The paddy is mainly cultivated in the rainy season. Only 9% of paddy grows in the dry season. Tobacco and polowijo crops are cultivated in the dry season as the succeeding crops after the wet season paddy. Sugarcane is cultivated thoughout a year. Upland crops such as cassava, sweet potato, peanuts and green beans are generally grown in the upland area.

The agricultural condition such as cropping patterns and cropping area are severely affected by amount of rainfall, its distribution of rainfall and irrigation water volume. In this study an average of data during the four years from 1981 to 1984 is presented as the value of the present condition in general.

The present cropping patterns prevailing in the paddy field in the Widas Extension Area are illustrated in Fig. 12.3. The average cropping area for each crop is estimated on the basis of the cropping intensity, for each crop in the four irrigation units related to the Widas Extension Area. The details are presented in Table 12.4 and is summarized below. An average cropping intensity in the recent four years is 171%.

CROPPING INTENSITY IN WIDAS EXTENSION AREA: 3,110 HA

	Acreage (ha)	Intensity (%)
Wet season paddy	2,707	87.1
Dry season paddy	269	8.6
Maize	761	24.5
Soybeans	709	22.8
Sugarcane	102	3.3
Tobacco	775	24.9
Total	5,323	171.2

The cropping intensity in the Widas Extension Area is the lowest among those in the other areas in the Widas basin as shown below;

Widas north area except the extension area	228 %
Widas south area controlled by Irrigation section Nganjuk	251 %
Widas south area controlled by Irrigation section Kediri	237 %
Warujayeng - Kertosono area	255 %

12.5.2 Farming practice and farm input

(a) Paddy

The cultivation pattern of paddy is affected by the availability of both irrigation water and labour in the area. The wet season paddy is planted at the onset of the monsoon, generally from December to January and harvested from March to April. The dry season paddy is planted in April and harvested in August. In the Widas Extension Area, improved high yielding variety, IR-36, has been recommended by Agricultural Service office and has been applied to almost all the paddy field. IR-36 is the early-matured high yielding variety and shows higher resistances against lodging and some kind of dwarf diseases. Paddy seeds distributed from the Agricultural Service office or companies are mostly used.

And seeds selected from last harvest are applied on a small scale. At present planting density is as thick as 28.4 hills/m^2. Area for nursery ranges from 200 m^2 to 700 m^2, averaging 340 m^2 equivalent to 3.4% of the paddy field.

Farming activities from seeding to harvesting are carried out by manpower and use of agricultural machineries is not common. The land preparation activities such as plowing, harrowing and puddling is carried out by two cows or buffalows in general. Transplanting method is common and direct seeding method is not common. Weeding is generally done two times at the period of 14 to 20 days and 25 to 30 days after transplanting. Irrigation water is supplied from the puddling time to the heading time at an interval of 10 to 20 days. Irrigation water, however, is not always distributed at the right time and in the right volume. Midseason drainage are widely used in the area. Fertilizer is applied with basic dressing and top dressing. Pesticides are spread at least 2 or 3 times by knapsack sprayer. However results of farmers interview's survey indicate that application of fertilizer and agro-chemicals is not properly practiced at the right time and in volume. Such application of farm inputs give one of the negative and/or ineffective actions for increasing unit yield. Harvesting of paddy is carried out by sickle. Ani-ani is not common. Threshing is done on the paddy field. After the paddy is air-dried on the yard, the paddy is packed with 75 kg or 108 kg hemp sack or other container. However moisture content of packed paddy is sometimes over 14% and impurity materials such as gravels is contained in the paddy, this fact make rice become worse. These sack and containers are transported to the milling factories. The estimated average dosages of farm input per ha are as follows; 42 kg of seed, 300 kg of urea, 130 kg of TSP, 3.7 ℓ of pestiside, 229 man days of labour requirement and 21 animal days for land preparation activities.

(b) Maize

Maize is one of the main polowijo crops and is grown without irrigation and planted in 40 - 50% of total cropping area annually. Maize is planted immediately after harvest of wet season paddy or dry season paddy. First maize is planted in April and harvested in July. Planting time of second maize varies depending on location. Broadly second maize is planted at July to August and harvested at October to November.

Local variety, "Ganjak Kodok" is now widely cultivated. Hibrid variety, having low resistance for drought, is not grown in spite of high yield because of unstable and low moisture content of soils under without irrigation at present condition. Land preparation is practiced by draft animals. Fertilizer is practiced 2 times as top dressing. Protection for pests and diseases are usually carried out by using Diazinon or Azodrin. Weeding is done by hand before top dressing. The estimated average dosages of farm inputs per ha are as follows; 26 kg of seed, 100 kg of urea, 65 kg of TSP, 1.8 kg of pesticide, 75 man days requirement and 19 animal days for land preparation activities.

(c) Soybeans

Soybeans are plantd two times. First soybeans are planted in April as the succeeding crops immediately after harvesting of wet season paddy and harvested in July. Second soybeans are planted in August after dry season paddy and harvested in October. Irrigation water is not provided. The predominant variety is Lung Gepak with the early matured period and No. 29 is partly grown. Seeding is mostly practiced by dibbling method without plowing. Hill seeding is practiced only in a small area. These seeds are purchased from the Agricultural Service office or companies. Fertilizer is generally applied one or two times as top dressing. On small areas basic dressing is carried out in case of hill seedings. Pests control is the most important farming practice for soybeans cultivation. Spraying of insecticides are carried out 3 or 5 times by knapsack type sprayer. The estimated average dosages of farm inputs per ha are as follows; 53 kg of seed, 43 kg of urea, 68 kg of TSP, 7.4 ℓ of pesticide and 67 man days of labour requirement.

(d) Sugarcane

Sugarcane is an important crops in the Widas Extension Area. Major varieties are PS41, PS56, BZ132, BZ142, POJ2878 and POJ3016. Their growth period is 14 to 16 months. Farming activities from seeding to harvesting are carried out mostly by man power. Estimated dosages of farm inputs per ha are 22,500 stalk, 150 kg of TSP, 450 kg of ammonium sulfate and 30 ℓ of agricultural chemicals. The labour requirement is estimated at about 620 man days.

(e) Tobacco

Tobacco is also an important crops in the area. The most major variety is NC2514. Farming is practiced without irrigation. Tobacco is planted at June and harvested at September to October in general. Farming activities from seeding to harvesting are carried by intensive man power. Top dressing prevails in the area and is practiced three times. Weeding is carried out generally one time 20 days after seeding. Pest control is executed 2 or 3 times in general. Estimated dosages of farm inputs per ha are 55 kg of N and 2.2 ℓ of insecticide.

12.5.3 Draft animals

As draft animal, cattles and buffaloes are used. According to statistics, there were 3,744 cattles and 384 buffaloes in the Widas Extension Area, in the past. These figures seem not to change largely. The draft animal force per farm house hold is 0.47 head. Usually, land preparation is made by one set of two cattles or buffaloes. Then, land preparation work needs cooperation of more than 4 farmers on an average.

12.6 Agriculture Crop Yield and Production

Crop yield under present condition is estimated on the basis of production data of Kecamatan level obtained from the Agricultural Service office in Kabupaten Nganjuk. Since yield of crops in the Widas Extension Area fluctuates year by year mainly due to variation of annual rainfall, irrigation water volume, and unexpected damage of pest and diseases, the present yield crops is therefore estimated as an average value during five years from 1979 to 1983 as shown in the following table. The details are presented in Table 12.5. The yield of crops is low in general.

(Unit: ton/ha)

	Paddy	Maize	Soybean	Sugarcane	Tobacco
Gondang	4.41	2.29	0.68	-	2.89
Lengkong	4.29	1.97	-	-	2.90
Average	4.38	2.23	0.68	56.9 /1	2.89

Source : Statistical Book of Kabupaten Nganjuk
Note : Unit yield = Production/planting area
/1 : Average in recent 2 years (1982, 1983)

Moreover, to confirm present yield of paddy, the survey on rice quality was conducted with respect to moisture content of paddy and impurities content. The survey results are shown below.

No. of Samples	Fresh Unhusked (g)	Water Losses (%)	Dry Unhusked (g)	Impu-rities (%)	Clean Unhusked (g)	Total Losses (%)
I	1,457	15.2	1,218	11.1	1,083	24.6
II	1,526	14.7	1,302	11.7	1,150	24.6
III	1,531	12.5	1,339	8.7	1,223	20.1
Average		14.1		10.5		23.1

Note: Variety : IR-36
Sampling: Desa Jegrek, Lengkong, August 8, 1985

As shown in the above table, moisture contents and impurities of paddy shows 10.5% of impurities content and 14.1% of moisture content. Thus, the actual unit yield of clean dry paddy is estimated to be 3.91 ton/ha by taking into consideration factor of impurities of paddy.

The low unit yield of paddy is considered to be derived from the following major constraints.

1. Insufficient irrigation water in volume and at the right time

2. Thickness of planting density

3. Improper application timing of nitrogen fertilizer

4. Insufficient amount of phosphatic and potassium fertilizer

5. Improper application of agro-chemicals

6. Improper weed control

7. Insufficient drying of paddy field in the middle stage of growth of paddy

As for polowijo crops, unit yield remains also low due to (1) farming without irrigation (2) low dosage level of fertilizer and agro-chemicals, (3) improper application of agro-chemicals and fertilizer and (4) no use of high yielding variety.

The agricultural crop production in the Widas Extension Area is estimated by multiplying cropping area and unit yield of crops and is presented in the table below.

	Crops	Cropping Area (ha)	Unit Yield (ton/ha)	Production (ton)
1.	Paddy	2,976	-	11,634
	- Wet season paddy	2,707	3.91	10,584
	- Dry season paddy	269	3.91	1,050
2.	Maize	761	2.23	1,697
3.	Soybean	709	0.68	482
4.	Sugarcane	102	56.9	5,803
5.	Tobacco	775	2.89	2,240

12.7 Agricultural Supporting System

12.7.1 Agricultural research service

In Indonesia, the agricultural research activity is centralized by the Agricultural Central Research Institute in Bogor of West Jawa. The institute has 6 Branch Research Stations in the Whole Indoneisa, they are located in East Jawa, Central Jawa, West Sumatra, North Sumatra, South Kalimantan, and South Sulawesi.

The primary activity of each station is to execute the experimental works under the instruction and supervision of the Agricultural Central Research Institute. One of the experimental works is production of new recommended varieties of the main food crops, such as paddy, maize, etc. The second activity of the station is to collect all informations related to the agricultural technical problems from farmers through the experimental farms spread over station's commanding areas. Based on the activities mentioned above, recommended new activities and improved agricultural techniques to be promoted are reported to the Central Research Institute of Agriculture. In the Branch Research Station in East Jawa is located near Malang (town of Kendalpayak). There are no experimental farms in the project area and its surrounding.

12.7.2 Agriculture extension service

The agricultural extension service in Indonesia has been intensified by establishing the Agency for Agricultural Education and Training (Badan Pendidikan, Latihan dan Penyuluhan Pertanian/BPLPP) under the Ministry of Agriculture.

In concluding the agricultural extension services in the field level, the government also established Kabupaten and rural Agricultural Extension Service (Balai Penyuluhan Pertanian/BPP). The functions of the Agricultural Extension Service are preparing extension programmes, training the agricultural extension workers, distributing recommended agricultural techniques and agricultural informations from the Agricultural Central Research Institute and other research institutions, and motivating the farmers in raising both the quantity and the quality of agricultural production.

The existing organization of the Agricultural Extension Service in Kabupaten level is illustrated on Fig. 12.4.

The main office of the Kabupaten Agricultural Extension Service is located in the same building of the Kabupaten Agricultural office in Nganjuk city. The Kabupaten Agricultural Extension Service is headed by a BPP chief, and assisted by an Agricultural Extension Specialist (Penyuluh Pertanian Specialis/PPS), and 2 Agricultural Extension Supervisors (Penyuluh Pertanian Madya/PPM).

In Kabupaten Nganjuk, there are 6 Rural Agricultural Exntesion Services. Each Rural Agricultural Extension Service which is headed by a BPP chief with the assistance of 2 Agricultural Extension Sueprvisors, has the work area of Rural Agricultural Extension Service (Wilayah Kerja Balai Penyuluhan Pertanian/WKBPP).

Under the Agricultural Extension Supervision in the Rural Agricultural Extension Service, there are 10 field extension workers (Penyuluh Pertanian Lapangan/PPL). One field extension worker involves 16 key farmers (kontak tani), and each key farmer has 10 - 20 farmers.

In the Widas Extension Area, there is a rural agricultural extension service situated in Desa Balonggebang in the Kecamatan of Gondang. The rural agricultural extension service in Balonggebang covers 3 Kecamatans, 10 work areas of rural agricultural extension service, 36 desas, 10,048 hectares of paddy field, and 22,943 farmers.

12.7.3 Seed multiplication

The government of Indonesia has placed particular emphasis on the improvement of timely supply of good seeds and implemented two national seeds project; National Seeds I Project and Seed II Project. These projects created the institutions such as the National Seeds Corporation (NSC) and the Seed Control and Certification Service (SCCS) for production, certification and distribution of high yielding seeds. Consequently, organized seed multiplication and processing have been extended and the timely supply of good seeds has improved.

Seeds go through a number of multiplication stages before reaching seed growers who sell the seeds either directly to farmers or through the village cooperative (KUDS) according to the BIMAS/INMAS Programme. SCCS certificates the seed quality standards.

12.7.4 BIMAS/INMAS programmes and agricultural credit

BIMAS/Bimbingan Massal (mass guidance for self-sufficiency in foodstuffs) and INMAS/Intensifikasi Massal (mass intensification) programmes has been promoted by Indonesian Government in the irrigated area since 1963. BIMAS is food plant intensification which is conducted by using the financial aid in the form of credit package, and INMAS is a food plant intensification which does not use any kinds of credit facilities.

There are credit packages for paddy and polowijo per hectare under the BIMAS programme. The credit package for paddy is divided into 3 credit packages, ie: package A, package B, and package C. Such kinds of credit packages in 1984/1985 are shown in ANNEX-6.

The interest rate of all credit packages per year is 1%, with the loan period of minimum 1 month up to maximum 7 months.

The BIMAS Programme operation is, in fact, a special function of Indonesian people Bank (Bank rakyat Indonesia/BRI), whose practice goes through Indonesian People Bank - Village Unit (Bank Rakyat Indonesia Unit Desa).

The regional office of Indonesia People Bank at Nganjuk has 21 Branch Offices, 2 of them are situated in Lengkong and Gondang. Total number of farmer under BIMAS Programme in Kabupaten Nganjuk, and in Kecamatan Lengkong and Gondang are shown in Table 12.6.

The coverage of BIMAS/INMAS Programmes in the 1984/1985 year was 2,478 ha of paddy and 1,334 ha of polowijo, while the paddy planted area was 3,000 ha and the polowijo planted area was 1,852 ha as shown in Table 12.7. It can be said the BIMAS/INMAS shows a good coverage.

12.7.5 Credit to estate crops

The government is now promoting the production of estate crops through UPP programme which is further divided into P4 (Estate Production Development Project) and PRPTE (Production Development of Export Crops). The principal objectives of UPP programme is to supply technology and marketing knowhow, and financial package to farmers through KUD.

Major estate crops in the project area are tobacco and sugarcane. However, tobacco in the project area is not included in P4 programme since the tobacco production is supported by tobacco companies through private contract.

As intensification programme of sugarcane, P4 programme is further divided into TRIS (program in paddy field) and TRIT (programme in upland field). In the project area, TRIT programme is taken up for production development of sugarcane. Credit packets based on TRIT programme mechanism of credit are shown in ANNEX-6. Credit is supplied to farmers from Indonesian People's Bank through KUD. All sugarcane produced in the project area is sent to sugar factory called Lestari (public factory) in order to produce sugar.

12.7.6 Farmer cooperative

The cooperative systems (BBUD/KUD) were established in accordance with the President's Decree Number 4, 1973. The BUUD (Badan Usaha Unit Desa/Village Unit Executive Body) is the pioneer of the KUD (Koperasi Unit Desa/Village Unit Cooperative), when the BUUD proves to be successful in changing out its duties, the BUUD is able to become the KUD, and may use credit facilities obtained from the government. The government purposes in establishing the BUUD/KUD are to realize the increase of the agricultural production, especially in main food crop, to make farmers certain in marketing their agricultural production and finally to raise the farmer's standard of living and welfare.

The BUUD/KUD is the important organization for farmers. It's operation is based on the purchase of farm outputs from farmers, and on drying, milling, storing, and then in selling the outputs to Food Purchasing Agency (BULOG/DOLOG), besides it sometimes operates a kiosk (a small store) to provide farmers with farm inputs, such as seed, fertilizer, agro-chemical, and others. The existing organization of KUD has four units under manager of KUD; production unit, processing unit, marketing unit, and credit unit as shown on Fig. 12.5.

In the project area, three BUUD/KUD are existing in Kec. Gondang, Kec. Lengkong and Kec. Ngluyu. Three rice milling units and four warehouses are available, besides the cooperative milling units, 22 private milling units are existing.

12.8 Marketing/Price of Crops and Farm Economy

12.8.1 Marketing and price of crops

Main marketing farm product in the project area is rice. There are three channels of rice marketing in the project area, directly to local market, to middlemen and to KUD. The surplus of paddy produced by the farmers is generally sold to KUD and/or middlemen. The paddy collected by KUD is sold to Dolog after milling, while the paddy collected by middlemen is sold to whole saler.

Table 12.8 shows the demand and supply of rice in Kab. Nganjuk. The distribution of rice to other areas consist of rice to outside Jawa, rice consumed in Surabaya (for government officials' use), and rice to markets outside (Kab. Nganjuk). Kab. Nganjuk has been a surplus area in terms of supply and demand condition. The average per capita consumption of rice is estimated around at 135 kg/c/year.

Table 12.9 shows the estimated marketable rice in the Project area. Although rice is in surplus in Kab. Nganjuk, the marketable rice is deficient in the Project area.

Table 12.10 shows the historical trend of price movement of gabah (Unhusked paddy) and beras (rice). The price of gabah and rice has increased at 9.5% and 10.2% p.a respectively between 1980/81 and 1985/86. The annual increase rate is higher in consumer price than in producer price. Financial prices of farm products and inputs used in present farm budget survey are the monthly averages of local market prices in 1984, which is shown in Table 12.11.

12.8.2 Farm economy

Farm budget survey indicates present economic activities of farmers in the Project area. The average farm size is 0.45 ha, on the basis of statistical data on socio-economic conditions in the Project area. Farm budget for the average size farmer is prepared as shown in Table 12.12, and summarized below;

Item		Amount ($Rp.10^3$)
I.	Gross income	705
	- Farm income	425
	- Non-farm income	280
II.	Expenditure	696
	- production cost	206
	- Living expenses	490
III.	Net reserve (I - II)	8

The characteristics on the farm budget survey are summarized below;

(1) Agriculture income derived from paddy production constitutes about 65% of total farm income. Farm income from upland crops is quite limited. As an estate crop, sugarcane is fairly profitable, compared to tobacco.

(2) Live stock income based on livestock per farm household shows a substantial contribution to gross income, whereas off-farm income is a small portion of gross income

(3) Living expenses occupied a large portion of expenditure, constituting about 70% of total expenditure.

(4) The net reserve is negligibly small. As a result, it is clear that economic conditions of farmers in the Project area remains at the subsistence level.

12.9 Present Irrigation System

12.9.1 Widas basin

According to the registration in the Irrigation Service, the total irrigation area in the basin is 45,126 ha consisting of 13,799 ha in the Widas north area, 17,981 ha in the Widas south area and 13,366 ha in the Warujayeng area. The Widas north area relys on the irrigation water obtained from the Widas main river and the Bening reservoir together with the tributaries originating from the Kedung ridges. The Widas south area is served by the Widas tributaries coming from the Mt. Wilis. The Warujayeng - Kertosono area obtains water directly from the Brantas river through Mrican intake and other small intakes.

The Irrigation networks in the Widas basin are shown in Fig. 12.6.

Irrigation organization structure in the East Java Province is composed of five hierarchies from the top to down such as Irrigation Service Surabaya, Irrigation District, Irrigation Section, Sub-section and finally Irrigation Units. The Irrigation units are the last organization carrying out the regular operation and maintenance of irrigation facilities and consists of an inspector (Juru) and a few gatekeepers.

Under the Irrigation Service Surabaya, the Brantas basin is organizationally divided into four Irrigation Districts and the irrigation area in the Widas basin belongs to the Irrigation District Kediri. The most of the irrigation area in the Widas basin are controlled by the Irrigation Section Nganjuk and some of the areas located in the piedomant of the Mt. Wilis are controlled by the Irrigation Section Kediri.

In the Irrigation Section Nganjuk, the irrigation area is divided into 19 Irrigation Units. The biggest is the Irrigation Unit Warujayeng - Kertosono. The average acreage controlled by one Irrigation Unit is 2,056 ha. In the Irrigation Section Kediri, the irrigation area is divided into 6 Irrigation Units. The average acreage controlled is 1,009 ha. Fig. 12.6 shows the area distribution. Fig. 12.7 shows the irrigation organization structure in the Widas river basin.

The Irrigation area is classified into three groups depending on the operation and maintenance degree of Irrigation Service as follows.

Technical area	:	Where water distribution upto tertiary canal head is controlled by the Irrigation Service
Semi-Technical area	:	Where primary canals are controlled by Irrigation Service
Non-technical area	:	Where water is used by farmers without control of the Irrigation Service.

As shown in Table 12.13, the technical area is about 37,200 ha in the Widas river basin, which account for 82% of the total area. The semi- technical and non-technical areas are about 2,800 ha and 5,100 ha, respectively.

The area distribution is summarized as follows.

		Technical Area	Semi-Technical Area	Non-Technical Area	Total
1.	Widas North Area	11,636	329	1,814	13,779
2.	Widas South Area	12,226	2,497	3,258	12,981
2-1	Irrigation Section Nganjuk	8,784	1,206	1,934	11,924
2-2	Irrigation Section Kediri	3,442	1,291	1,324	6,057
3.	Warujayeng-Kertosono	13,366	-	-	13,366
	Total	37,228	2,826	5,072	45,126

As for the irrigation facilities, site investigation is carried out and the canal length of each Irrigation Unit is examined based on the data obtained from the Irrigation Service as shown in Table 12.14. The canal density is the highest in the Widas south area of Irrigation Section Nganjuk among areas. It is 84 m/ha. The Warujayen - Kertosono - Besuli area is in density of 59 m/ha. The third is the Widas north area except the Widas Extension Area. The canal density is 37 m/ha. The last is Widas Extension Area. The density is only 17 m/ha. The most of the canals in the Widas basin are non-lining canals.

In all the areas, the main and secondary canals are relatively maintained well, however the tertiary and quaternary canals are found to be cut in small stretches in the canal banks. Also, many of measuring devices are not provided or deteriorated and not functioning well.

From the view point of the canal density, in the Widas south area the most of the irrigation areas are estimated to be delivered directly from the on-farm canals, while, the plot to plot irrigation through field ridges is obliged to be performed in the Widas Extension Area.

Besides of the surface irrigation, groundwater irrigation is executed. These tubewells was partially developed or will be developed by P2AT. The distribution is shown in Fig. 12.8. It leans the Widas south area together with Widas Extension Area.

12.9.2 Widas Extension Area

Fig. 12.6 shows the location of the Widas Extension Area. The objective area consists of four Irrigation Units such as Irrigation Unit Tretes, Ketandan, Sumber Kepuh and Jurang Dandang. The Irrigation Unit Tretes belongs to the Sub-section Gondang. Others belong to sub-section Lengkong. Irrigation area of each Irrigation Unit registered by the Irrigation Service is as follows.

Tretes	1,360 ha	
Ketandan	766 ha	
Sumber Kepuh	135 ha	Lengkong north area
Jurang Dandang	496 ha	
Total	2,757 ha	

The Tretes area is served with small tributaries of the Widas river originating from the Kedung Ridge and tubwells developed by P2AT. Major tributaries utilized for the irrigation are Senggon river, Tretes river and Sumberagung river from west. The total drainage area of these rivers is only 11.5 km^2. The Jaan river which is running east side of the Tretes area is not utilized for irrigation. This river has catchment area of about 10 km^2. On the Senggon river and the Sumberagung river, there exist small ponds having storage capacities of 0.59×10^6 m^3 in total.

As shown in Fig. 12.8, 10 tubewells exist in Tretes area. Out of 10, five tubewells are already completed and remainders are waiting for pumping equipment. The installation of the pumping equipment is expected in this year according to the information from P2AT. Features of tubewells are shown in Table 12.15. Total irrigation area is 403 ha. Due to the poor development of the aquifer, there is little possibility to extend the groundwater development.

The canal density in the Tretes area is only 12 m/ha. The irrigation is commonly practiced by field plot to plot through field ridges in the rainy season. In the dry season, it can be seen that farmers take irrigation water from shallow wells and distributed to the field by man power.

The Ketandan area is almost the same situation as the Tretes area. Water source is the Ketandan river. This catchment area is 22.2 km^2. The irrigation discharge is 0.25 m^3/sec on an average in the rainy season but in the dry season, it is negligibly small compared with the irrigation area. One tubewell constructed by P2AT is existing but not yet operated with pumping equipment. The irrigation area is expected to be 45 ha which only accounts for 5% of total irrigation area. Canal density is 31 m/ha.

The Sumberkepuh is area where is endowed with the water among the Irrigation Units in the Widas Extension Area since rather large pond having a storage capacity of 1.32×10^6 m^3 contributes to the irrigation area of 135 ha. The canal density is 32 m/ha. The irrigation facilities are maintained well. Double cropping of paddy is prevailing in vicinity of the Sumberkepuh pond.

The Jurang Dandang has also two ponds known as Logawe pond and Sumbersono pond, however, the total storage capacity is as small as 0.21×10^6 m^3 which is much behind the crop water requirement in the dry season. The canal density is 8 m/ha.

As a whole, the present constraints for irrigation are summarized as follows;

(1) Water availability is very poor compared with irrigatoin acreage (This is further discussed in Section 12.10)

(2) Canal density is insufficient to use irrigation water efficiently

(3) Dry season irrigation practice requires much labour input to carry water by man power.

Solution of the constraint of item (1) depends on the development of the water creation by dam construction since the groundwater resources are limited due to the poor development of aquifer. Improvement of items (2) and (3) is expected by the provision of irrigation facilities especially on-farm level and reinforcement and improvement of maintenance and operation of the irrigation facilities.

12.9.3 Irrigation practice in Widas Extension Area

As previously stated, the Widas Extension Area has insufficient water resources even in the rainy season to cultivate paddy and little water resources in the dry season to cultivate polowijo crops.

In the rainy season, according to the interview survey, the water taken from tributaries of the Widas river is continuously distributed to the field through poor irrigation systems. Rotational irrigation is not performed in the area. For the water requirement of the paddy, it is asusmed that the river water at storm time is also utilized for puddling by artificial flooding.

The irrigation is practiced with a field plot to the downstream field plots through ridges owing to the lack of canal systems.

In the dry season, according to the interview survey to inspectors so-called Juru, rotational irrigation is performed daily. However the surface water is not available in the most of the area, thus the irrigation water is taken from the shallow wells, which are widely distributed in the area, and distributed by man-power.

12.10 Assessment of Present Water Resources in Widas Basin

12.10.1 Methodology

Water resources are surface runoff and groundwater. Available water resources of surface runoff depend on runoff of rivers and the capacity of intake and irrigation facilities. In the dry season, most of the river water is taken by intakes, and river flow after the intakes nearly become negligibly small. In the rainy season, flood occurs, however, the flood runoff can be hardly caught by intakes, since the flood runoff is very short in the period and big in the amount compared with the intake capacity owing to the steep and short river sketches in the drainage area. Thus, the available runoff are mostly baseflows with no reservoir condition. If the baseflow is larger than the intake capacity, the excess can not be used. In other words, the excess is not available water resource. Conversely if the baseflow is less than the intake capacity, the baseflow is available water resource and assumed to be taken by intakes. Therefore, intake discharge is mostly regarded as available water resources.

Available groundwater is lifted up by tubewells.

Taking the aboves into account, sum of the intake discharge and lifted-water discharge are compared with the irrigation water requirements estimated based on the present cropping pattern of each of irrigation area hydrologically divided in the Widas basin as follows.

Widas south, Kedungsoko basin
Widas south, Kuncir - Ulo basin
Widas north, Widas and the northern tributary basin
Widas Extension Area

All the data used for this study are compiled in Section 7.1 in ANNEX 7.

12.10.2 Assessment

The calculation results are shown in Table 12.16 and summarized as follows.

Unit: m^3/sec

Area	Year	Rainy Season			Dry Season		
		Intake Dis-charge	Water Require-ment	Differen-ce	Intake Dis-charge	Water Require-ment	Differen-ce
Kedungsoko Basin	1981	6.00	4.02	1.98	1.41	4.30	-2.89
	1982	6.70	5.65	1.05	1.94	5.47	-3.53
	1983	6.86	2.93	3.93	2.68	5.25	-2.57
Kuncir-Ulo Basin	1981	4.16	3.70	0.46	1.71	3.11	-1.40
	1982	4.17	3.51	0.66	1.19	3.87	-2.68
	1983	4.41	2.23	2.18	1.71	3.98	-2.27
Widas North	1981	4.38	3.82	0.56	1.30	2.50	-1.20
	1982	4.21	3.22	0.99	0.90	3.86	-2.96
	1983	4.74	1.37	3.37	2.42	3.33	-0.91
Widas Extension	1981	0.19	1.05	-0.86	0.07	0.85	-0.78
	1982	0.65	0.86	-0.21	0.12	0.72	-0.60
	1983	0.60	0.57	0.03	0.18	0.62	-0.44

These results indicate that the water resources are enough to irrigate all the fields in the rainy season with the exception of the Widas Extension Area, but in the dry season, all the irrigation areas suffer from the shortage of water. Based on the above results and the field investigation, it is presumed that the irrigation water supply is concentrated on paddy cultivation in the dry season and polowijo crops are almost under no-irrigation condition in most of the area. The Widas Extension Area is handicapped with the water shortage even in the rainy season. Paddy planted widely in the rainy season is assumed to rely largely on the rainfall in this season. In dry season, more severe shortage is revealed. Polowijo crops are seemed to be cultivated with retention water stored in the soil layer in the rainy season and poor irrigation supply from the shallow wells with which the project area is dotted.

Table 12.1 CHARACTERISTICS OF SOIL SERIES PREVAILING AND IN TRETES AREA

Mapping Unit	Soil Series	Physiography	Parent Material	Area Ha (%)
2.	Soil series 2 : very dark gray, deep, moderately well drained, clayey (silty to clay loam), slightly calcareous, high base saturation and cation exchange capacity (Vertic Eutropept in subgroup)	Plain to lightly dissected plain	Pleistocene	295 (14.6)
3.	Soil series 3 : dark gray, deep, imperfectly drained, clayey, non acid, high base saturation and cation exchange capacity (Vertic Eutropepts in subgroup)	Plain to slightly dissected plain	Alluvium	299 (14.8)
4.	Soil series 4 : grayish brown, deep, moderately well drained clayey (silty to clay loam), non acid, high base saturation and cation exchange capacity (Vertic Tropaquept in subgroup)	Level plain	Alluvium	303 (15.0)
6.	Soil series 5 : dark grayish brown, deep imperfectly to moderately well drained, clayey, non acid, high base saturation and cation exchange capacity (Vertic Tropaquepts in subgroup)	Plain almost slightly dissected plain	Alluvium	242 (12.0)
7.	Soil series 6 : very dark gray, poorly drained, fine clayey, non acid, high base saturation and cation exchange capacity (Typic Pelusterts in subgroup)	Level plain	Alluvium	62 (3.1)
9.	Soil series 7 : gray to dark gray what poorly drained to imperfectly drained, clayey, high base saturation and cation exchange capacity (Typic Pullusterts in subgroup)	Almost level plain	Alluvium	324 (16.1)
10.	Soil series 10 : very dark gray, deep, imperfectly drained, calcareous, clayey, high base saturation and cation exchange capacity (Typic Pellusterts in subgroup)	Level plain	Alluvium	126 (6.3)

Mapping Unit	Soil Series	Physiography	Parent Material	Area Ha (%)
11.	Soil series 13 : dark gray, deep, imperfectly drained, very fine clayey, calcareous, high base saturation and cation exchange capacity (Typic Pellusterts in subgroup)	Level plain	Alluvium	324 (16.1)
12.	Soil series 9 : dark grayish brown, deep, clayey, somewhat poorly drained, non acid, high base saturating and cation exchange capacity (Typic Pellusterts in subgroup)	Sloping terrain	Alluvium	39 (1.9)
	T o t a l			2,014 (100.0)

Table 12.2 CHARACTERISTICS OF SOIL SERIES PREVAILING IN LENGKONG AREA

Mapping Unit	Soil series	Physiography	Parent Material	Area Ha (%)
1.	Soil series 3 : dark gray, deep, somewhat poorly drained, non acid, fine loamy, Vertic Fluvaquents	Old levee (1-2%)	Alluvium	8 (0.5)
2.	Soil series 1 : grayish brown, deep, moderately well, drained, fine loamy, mixed, non acid, Typic Ustifluvents	Recent levee slightly conves (2-3%)	Alluvium and colluvium	2 (0.1)
3.	Soil series 2 : dark grayish, brown, deep, moderately well drained, non acid, Typic Ustifluvents	Alluvial valley (2-3%)	Alluvium mixed with volcanic products	78 (4.9)
4.	Soil series 7 : dark grayish brown, deep, imperfectly to moderately well drained, clayey, non acid, Vertic Tropaquepts	Alluvial valley (2-3%	Alluvium, mixed with volcanic products	199 (12.4)
5.	Soil series 4 : dark gray, deep, non acid, moderately well drained	Level plain	Alluvium, limestone	312 (19.4)

Mapping Unit	Soil Series	Physiography	Parent Material	Area Ha (%)
	very fine clayey, monomori-llinitic, Typic Pellusterts	(0-1%)	derived	
6.	Soil series 6 : dark gray, slightly deep-deep, non acid, imperfectly drained clayey, Vertic Eutropepts	Level plain (0-1%	Alluvium	464 (28.9)
7.	Soil series 5 : dark gray, deep, calcareous, somewhat poorly drained, very fine clayey, Typic Pellusterts	Almost level slightly dissected plain (3-5%)	Alluvium and Colluvium	89 (5.5)
8.	Association soil series 4 : dark gray, deep, non acid, moderately well drained, very fine clayey, montmorillinitic, Typic Pellusterts, and soil series 6 : dark gray, slightly deep to deep, non acid imperfectly drained, clayey, Vertic Eutropepts	Level plain (0-1%)	Alluvium	176 (11.0)
9.	Association soil series 3 : dark gray, deep, somewhat poorly drained, non acid fine loamy Vertic Fluvaquents, and soil series 7 : dark grayish brown, deep, imperfectly to moderately well drained, clayey, non acid Vertic Tropaquepts	Alluvial valley (2-3%)	Alluvium	122 (7.6)
10.	Association soil series 6 : dark gray, slightly deep, non acid, imperfectly drained, clayey, Vertic Eutropepts and soil series 5 : dark gray, deep, calcareous, somewhat poorly drained, very fine clayey, Typic Pellusterts	Almost level slightly dissected plain	Alluvium and colluvium derived from limestone	155 (9.7)
	T o t a l			1,605 (100.0)

Table 12.3 LAND USE IN VILLAGE LEVEL RELATED TO THE PROJECT AREA

(Unit: ha)

No.	Name of Village	Paddy Field	Upland Field	Sub-total	Yard	Settle-ment	Forest	Others	Total
1.	Jaan	333.00	75.59	408.59	25.99	19.00	270.00	1.23	724.81
2.	Sumberagung	145.87	18.25	164.12	21.65	14.00	450.00	8.73	658.50
3.	Nguyung	208.00	86.13	294.13	20.35	15.00	1,011.00	0.44	1,340.92
4.	Balonggebang	261.00	55.51	316.51	44.00	40.00	360.00	67.54	828.52
5.	Kedungglugu	179.00	14.85	193.85	11.51	10.00	-	1.36	216.72
6.	Ketawang	334.38	-	334.38	30.01	22.00	-	2.45	388.84
7.	Kedungmlaten	96.05	74.80	170.85	10.69	14.65	-	44.11	240.30
8.	Jegrek	86.10	17.68	103.78	8.96	16.08	-	11.01	139.89
9.	Lengkong	129.06	17.23	146.29	8.76	16.11	28.00	10.14	209.30
10.	Banjardowo	146.84	94.54	241.38	10.17	20.30	362.00	18.80	652.65
11.	Prayungan	145.67	75.29	220.96	23.47	32.50	831.10	10.28	1,118.31
12.	Sawahan	131.63	-	131.63	14.35	36.20	-	6.71	188.89
13.	Ngringin	186.31	15.15	201.46	15.80	57.40	0.35	6.93	281.94
14.	Ketandan	300.67	59.71	360.38	20.16	51.25	1,753.00	4.80	2,189.59
15.	Sumberkepuh	80.72	36.25	116.97	10.10	18.10	723.00	35.55	903.72
16.	Sumbersono	49.32	33.81	83.13	8.43	14.15	573.00	8.75	687.46
17.	Jatipungkur	157.99	-	157.99	8.25	15.10	-	1.67	183.01
Total Area (ha)		2,971.61	674.79	3,646.40	292.65	411.84	6,361.45	240.56	10,952.90
Proportional Extent (%)		(27.13)	(6.16)	(33.29)	(2.67)	(3.76)	(58.08)	(2.20)	(100.00)

Table 12.4 TOTAL PRESENT CROPPING AREA AND INTENSITY IN IRRIGATION UNITS RELATED TO WIDAS EXTENSION AREA: 2,758 HA

(Unit : ha)

Cropping	1981	1982	1983	1984	Average
Wet Season Paddy	2,545 (92.2)	2,484 (90.1)	2,315 (83.9)	2,266 (82.2)	2,403 (87.1)
Dry Season Paddy	341 (8.4)	363 (13.2)	198 (7.2)	284 (10.3)	269 (9.8)
Polowijo I	1,127 (40.9)	759 (27.5)	793 (28.8)	639 (23.2)	830 (30.1)
Polowijo II	714 (25.9)	438 (15.9)	364 (13.2)	378 (13.2)	474 (17.2)
Sugarcane	30 (1.1)	66 (2.4)	147 (5.3)	164 (5.9)	102 (3.7)
Tobacco	(427 (15.5)	738 (26.8)	926 (33.6)	1,008 (36.5)	775 (28.1)
Total	5,074 (184)	4,848 (176)	4,753 (172)	4,739 (172)	4,759 (176)

Note : Figure in parenthesis are cropping intensities.
Source : Keadaan Irigasi obtained Irrigasi Nganjuk

* * * *

Estimation of the average cropping area for each crops

Paddy field in the Widas extension area : 3,109 ha
Paddy field inthe four irrigation units : 2,758 ha

Wet Season Paddy	3,109 x 0,871	=	2,707 ha	(87.1)
Dry Season Paddy	2,758 x 0,098	=	269 ha	(8.6)
Maize	3,109 x 0.473 /2 x 0.518 /1	=	761	(24.5)
Soybean	3,109 x 0.473 /2 x 0.482 /1	=	709	(22.8)
Sugarcane	2,758 x 0.037	=	102	(3.3)
Tobacco	2,758 x 0.281	=	775	(24.9)
Total			5,323	(171.0)

Remarks : /1 : See table below
/2 : Total intensity of polowijo crops (0.301 + 0.172 = 0.473)

PLANTED AREA OF POLOWIJO CROPS IN THE WIDAS EXTENSION AREA

(Unit : ha)

	1981/82	1983/84	Average	Proportional Extent %
Maize	915	898	906.5	(51.8)
Soybean	815	870	842.5	(48.2)
Total	1,730	1,768	1,749.0	(100.0)

Table 12.5 AVERAGE UNIT YIELD OF CROPS IN KECAMATANS GONDANG AND LENGKONG

(Unit : ton/ha)

Crops	Kecamatan	1979	1980	1981	1982	1983	Average
Paddy	Gondang	3.30	5.09	5.31	5.21	3.14	4.41
	Lengkong	2.81	4.40	4.91	4.86	4.70	4.29 (4.38)/1
Maize	Gondang	2.01	2.39	2.69	2.45	1.90	2.29 (2.23)/1
	Lengkong	2.26	2.23	2.02	2.18	1.14	1.97
Soybeans	Gondang	-	-	0.75	0.76	0.54	0.68 (0.68)
	Lengkong	-	-	-	-	-	-
Sugarcane	Gondang	-	-	-	57.1	56.6	56.9
	Lengkong						
Tobacco	Gondang	-	-	2.79	2.99	-	2.89
	Lengkong	-	-	2.80	2.99	-	2.90 (2.89)/1

Remarks : /1: Weighted average

Source : Data on paddy, maize, and soybeans are derived from Agricultural Office of Kec. Lengkong and Gondang
Data on sugarcane and tobacco are from Estate Crop Office

Table 12.6 THE NUMBER OF FARMERS UNDER BIMAS LOAN AND AMOUNT OF LOAN

No.	Name of Kecamatan/Desa	No. of farmer			Amount of Loan		
		1982/1983	1983/1984	1984/1985	1982/1983	1983/1984	1984/1985
I.	Kecamatan Gondang :						
1.	Balonggebang	394	358	343	12,900,000	9,046,125	11,040,000
2.	Ngujung	120	114	97	4,245,000	4,773,000	4,140,000
3.	Ketawang	70	122	98	2,257,500	5,160,000	3,105,000
4.	Sumberagung	128	110	76	5,805,000	3,386,250	3,450,000
5.	Kedungglugu	105	43	104	5,192,250	1,784,375	4,830,000
6.	Jaan	174	106	173	5,176,125	4,515,000	5,013,125
II.	Kecamatan Lengkong :						
7.	Lengkong	52	46	-	2,830,000	2,257,500	-
8.	Jatipunggur	139	127	129	5,150,000	3,870,000	4,627,500
9.	Kedungmlaten	-	-	-	-	-	-
10.	Jegreg	37	28	38	1,415,000	967,500	1,542,500
11.	Ngringin	97	85	112	4,245,000	3,568,750	4,627,500
12.	Ketandan	108	101	102	4,245,000	3,547,500	4,241,875
13.	Sumberkepuh	40	24	43	1,935,000	999,250	2,070,000
14.	Prayungan	213	187	175	7,075,000	5,031,000	6,170,000
15.	Sumbersono	22	28	25	836,500	645,000	925,500
16.	Sawahan	135	137	96	5,160,000	4,996,250	6,170,000
17.	Banjardowo	56	-	58	3,120,000	- -	2,313,750
Kecamatan Ngluyu :							
18.	Ngluyu /1	-	-	-	-	-	-
	Total						

Source : Bank Rakyat Indonesia - Unit Desa / Indonesian People - Village Unit.

Remarks : /1 Unknown

Table 12.7 PLANTED AREA OF PADDY UNDER BIMAS/INMAS PROGRAMMES AND TOTAL PLANTED AREA OF PADDY IN WIDAS EXTENSION AREA IN 1984 / 1985

	Crop / BIMAS/INMAS	Planted Area under BIMAS/INMAS (Ha)				Total Planted area (Ha)			
		Kec. Gondang	Kec. Lengkong	Kec. Ngluyu	Total	Kec. Gondang	Kec. Lengkong	Kec. Ngluyu	Total
I.	Dry Season Paddy by BIMAS programme	-	-	-	-				
	Dry Season Paddy by INMAS programme	125	160	20	305	1,652	1,159	189	3,000
II.	Wet Season Paddy By BIMAS programme	350	427	50	827				
	Wet Season Paddy by INMAS programme	821	430	95	1,346				
	Total	1,296	1,017	165	2,478	1,652	1,159	189	3,000

Source : Agricultural Office in Kabupaten Nganjuk

Table 12.7 PLANTED AREA OF POLOWIJO UNDER BIMAS/INMAS PROGRAMMES AND TOTAL PLANTED AREA OF POLOWIJO IN WIDAS EXTENSION AREA IN 1984/1985

	Crop / BIMAS/INMAS	Planted Area under BIMAS/INMAS (Ha)				Total Planted Area (Ha)			
		Kec. Gondang	Kec. Lengkong	Kec. Ngluyu	Total	Kec. Gondang	Kec. Lengkong	Kec. Ngluyu	Total
I.	Maize under BIMAS programme	150	-	-	150	686	221	96	1,003
	Maize under INMAS prog.	380	160	5	545				
	Sub total I	530	160	5	695	686	221	96	1,003
II.	Soybean under BIMAS progamme	-	-	-	-	843	-	6	849
	Soybean under INMAS programme	635	4	-	639				
	Sub total II	635	4	-	639	843	-	6	849
	Total I + II	1,165	164	5	1,334	1,529	221	102	1,852

Source : Agricultural Office in Kabupaten Nganjuk.

Table 12.8 DEMAND AND SUPLY OF RICE IN KABUPATEN NGANJUK

Year	Supply /1 Production of Paddy (ton)	/2 Impulity + Waste (ton)	/3 Paddy to other Area (ton)	Paddy in Kab.Nganjuk (ton)	/4 Total Suplly of Rice (ton)	Demand Population	Per capita consumption (kg)	Total Demand of Rice (ton)	Surplus or Deficit (ton)
1975	228,950	28,619	40,066	160,265	104,172	803,173	129	104,172	26,043
1976	238,144	29,768	41,675	166,701	108,355	830,814	130	108,355	27,089
1977	212,062	26,507	37,111	148,444	96,488	835,916	115	96,488	24,122
1978	241,682	30,218	42,293	169,171	109,961	840,734	131	109,961	27,490
1979	208,600	26,075	36,505	146,020	94,913	854,485	111	94,913	23,728
1980	271,662	33,958	47,541	190,163	123,605	882,332	140	123,605	30,902
1981	301,878	37,735	52,829	211,314	137,354	891,685	154	137,354	34,339
1982	297,524	37,190	52,067	208,267	135,374	901,136	150	135,374	33,844
1983	388,430	38,554	53,975	215,901	140,335	910,688	154	140,335	35,084
Average	256,548	32,069	44,896	179,583	116,729	861,218	134.9	116,729	29,182

Source : Dalam Angka of Kabupaten Nganjuk

Note : /1 From Regional Income of Kab. Nganjuk

/2 Waste (2%) + impulty (10.5%)

/3 Paddy to other area is 20% of total production of paddy

/4 Milling recovery rate from paddy to rice is 65% (Based on interview survey of Dolog).

Table 12.9 MARKETABLE RICE IN WIDAS EXTENSION AREA

Year	Production: Production of Paddy (ton)/1	Impulity + Waste (ton)/2	Rice (ton)/3	Demand: Population /4	Per capita consumption (kg)	Demand of Rice (ton)	Marketable Rice (ton)
Present Condition							
1985	11,630	1,459	6,610	47,800	140/5	6,692	- 82
With Project							
1993	16,880	2,110	9,600	51,760	140	7,241	2,354
2000	16,880	2,110	9,600	55,500	140	7,770	1,830

Note : /1 See Table 13.8

/2 Waste (2%) + Impulity(10.5%)

/3 Milling recovery rate from paddy to rice is 65% based on interview survey at Dolog

/4 Population in 1980 x Population growth rate = 45,487 x (1 + 0.01)

/5 The average per capita consumption of rice between 1979 and 1980. Future per capita consumption of rice is estimated to be the same as present level.

Table 12.10 HISTORICAL PRICE MOVEMENT OF PADDY AND RICE

Unit : (Rp.)

	Paddy	Rice
1980/81	111	175
1981/82	128	195
1982/83	146	214
1983/84	156	238
1984/85	165	270
1985/86	175	285

Source : Agricultural Office of Kab. Nganjuk

Table 12.11 CONSUMER PRICE OF CROPS IN 1984

Unit : Rp/Kg.

1984	1	2	3	4	5	6	7	8	9	10	11	12
Gabah	-	-	-	-	-	-	-	-	-	-	-	-
Beras	275	275	250	250	250	250	250	250	250	285	275	275
Jagung	95	100	100	100	110	110	110	110	145	120	100	105
Kedelai	450	500	500	625	600	450	350	400	450	475	475	475
Bawang merah	400	400	1,200	1,200	1,200	1,200	400	400	500	350	350	500

Source : Statistical Office of Kab. Nganjuk

Table 12.12 FARM ECONOMY IN WIDAS EXTENSION AREA AT PRESENT (Average farm size : 0.45 Ha)

No.	Items	Area (Ha)	Unit yield (ton/ha)	Unit Price (Rp./Kg)	Amount (Rp)
I.	Gross income				704,026
1.	Farm income				424,526
	Wet season paddy	0.39	3.91	163.66	249,565
	Dry season paddy	0.04	3.91	163.66	25,596
	Maize	0.11	2.23	109.16	26,777
	Soybean	0.10	0.68	480	32,640
	Sugarcane	0.02	56.89 (5.69) /1	539	61,338
	Tobacco	0.11	2.89	90	28,610
	Livestock	-	-	-	189,500
2.	Off farm income /2	-	-	-	90,000
II.	Expenditures				696,463
1.	Production cost				206,463
	Wet season paddy	0.39			120,939
	Dry season paddy	0.04			12,404
	Maize	0.11			14,498
	Soybean	0.10			17,870
	Sugarcane	0.02			16,560
	Tobacco	0.12			24,192
2.	Living expenses	-			490,000
III.	Net income	-			7,563

Note ; /1 : Conversion rate from sugarcane to sugar is around 10%

/2 : Average off-farm income surveyed by the Study Team

Table 12.13 IRRIGATION AREA CLASSES OF EACH IRRIGATION UNIT ON WIDAS BASIN

Name of Irrigation Unit	Technical (Ha)	Semi-Technical (Ha)	Non-Technical (Ha)	Total (Ha)
(1) Widas North Area				
DI. Kedunggupit	819	-	-	819
DI. Kedungmaron	815	80	109	1,004
DI. Rejoso	1,957	-	-	1,957
DI. Kedungpadang	632	-	-	632
DI. Senggowar	2,368	249	-	2,617
DI. Widas	3,114	-	478	3,592
DI. Jurangdandang	431	-	65	496
DI. Ketandan	766	-	-	766
DI. Sumber Kepuh	135	-	-	135
DI. Tretes	599	-	761	1,360
DI. Perning	-	-	401	401
Sub-total	11,636	329	1,814	13,779
(2) Widas South Area				
Irrigation Section Nganjuk				
DI. Kedungpedet	2,289	-	37	2,326
DI. Kuncir	2,739	1,206	692	4,637
DI. Bodor	2,981	-	1,205	4,186
DI. Kedungsoko	775	-	-	775
Sub-total	8,784	1,206	1,934	11,924
Irrigation Section Kediri				
DI. Bakung	173	152	225	550
DI. Kolokoso	270	66	38	374
DI. Hardisingat	620	320	116	1,056
DI. Bendomongal	336	559	362	1,257
DI. Bendokrosok	788	-	99	887
DI. Genjeng	1,255	194	484	1,933
Sub-total	3,442	1,291	1,324	6,057
(3) Warujayeng				
DI. Warujayeng & Kertosono	12,827	-	-	12,827
DI. Besuk	539	-	-	539
Sub-total	13,366	-	-	13,366
Total	**37,228**	**2,826**	**5,072**	**45,126**

Source: Daftar Penetapan Baku Sawah Jawa Timur Tahun 1984, DPUD Prop. Daerah TK. I. Jatim Bidang Pengairan,

Table 12.14 SUMMARY OF PRESENT CANAL LENGTH AND DENSITY

No.	Name of DI	Irrigation Area (ha)	Canal Length (m)			
			Main		Secondary	
			Lining	Without Lining	Lining	Without Lining
I.	WIDAS KEDIRI	6,057	-	-	1,688	18,539
II.	WIDAS SOUTH	11,924	-	-	33,179	203,040
III.	WIDAS NORTH	11,021	14,295	12,710	10,161	73,240
IV.	WIDAS EXTENTION	2,758	-	-	866	10,120
V.	WARUJAYENG-KERTO-SONO + BESUK	13,366	65	21,044	66,632	104,693
	Total	45,126	14,360	33,754	112,525	409,632

No.	Name of DI	Canal Length (m) Tertiary & Quartenary		Total Length (m)	Canal Density (m/Ha)
		Lining	Without Lining		
I.	WIDAS KEDIRI	-	336,533	356,760	59
II.	WIDAS SOUTH	167,509	592,277	996,005	84
III.	WIDAS NORTH	-	300,565	410,971	37
IV.	WIDAS EXTENSION	-	36,979	47,965	17
V.	WARUJAYENG-KERTOSONO + BESUK	35,320	560,671	788,425	59
	Total	202,829	1,827,025	2,600,126	58

Table 12.15 FEATURES OF TUBEWELLS IN WIDAS EXTENSION AREA

No. of Tubewell	Village	Irri-gation Area (Ha)	Pump Capa-city (l/sec)	Actual Discharge (l/sec)	Depth of Well (m)	Remark
I. KEC. GONDANG						
1. TW 105	Jaan	47.18	60	33	144	Under Operation
2. TW 150	Sanggrahan	29.94	60	20	84	- ditto -
3. TW 152	Jaan	43.93	60	27	91	- ditto -
4. TW 169 (K - 8)	Jaan	48.25	45	-	141	Waiting for pump equipment
5. TW 174 (K - 7)	Sumber-agung	45.14	45	-	150	- ditto -
6. TW 176 (K - 6)	Ketawang	43.25	45	-	153	- ditto -
7. TW 177 (K - 5)	Ngujung	39.50	45	-	150	- ditto -
8. TW 178 (K - 4)	Balong-gebang	32.75	45	-	148	- ditto -
II. KEC. LENGKONG						
1. TW 151	Banjardowo	41.13	60	32	84	Under Operation
2. TW 172 (K - 9)	Jatipung-gur	44.54	45	-	141	Waiting for pump equipment
Total		415.61	510			

Source : BP. P_2AT Jawa Timur, Bagian Proyek Kediri, June 1985.

Note: Besides one tubewell managed by Desa Basunggubeng irrigate 42 ha.

Table 12.16 COMPARISON OF INTAKE DISCHARGE AND IRRIGATION REQUIREMENT (1/6)

	KEDUNGSOKO BASIN YEAR 1981					KEDUNG SOKO BASIN YEAR 1982				
MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W. REQUIRE-MENT II M3/SEC	IRRI. REQUIRE-MENT III M3/SEC	I - II M3/SEC	I- III M3/SEC	INTAKE DISCH-ARGE I M3/SEC	CROP.W REQUIRE MENT II M3/SEC	IRRI. REQUIRE MENT III M3/SEC	I-II M3/SEC	I-III M3/SEC
JAN 1ST	7.91	3.92	6.12	3.99	1.79	8.02	5.02	7.84	3	.18
2ND	8.56	4.35	6.79	4.21	1.77	9.94	3.56	5.57	6.38	4.37
3RD	8.35	.28	.44	8.07	7.91	10.26	0	0	10.26	10.26
FEB 1ST	8.18	0	0	8.18	8.18	13.52	0	0	13.52	13.52
2ND	8.2	4.11	6.42	4.09	1.78	9.62	4.37	6.83	5.25	2.79
3RD	8.48	0	0	8.48	8.48	8.98	1.3	2.04	7.68	6.94
MAR 1ST	8.18	0	0	8.18	8.18	8.69	1.83	2.86	6.86	5.83
2ND	8.25	.85	1.32	7.4	6.93	7.59	3.22	5.02	4.37	2.57
3RD	6.05	1.41	2.21	4.64	3.84	5.84	5.13	8.04	.71	-2.2
APR 1ST	5.2	3.98	6.28	1.22	-1.08	4.7	4.11	6.47	.59	-1.77
2ND	3.2	2.56	4.04	.64	-.84	3.35	3.07	4.86	.28	-1.51
3RD	2.6	1.56	2.5	1.04	.1	3.84	3.82	6.19	.02	-2.35
MAY 1ST	2.6	3.06	5.09	-.46	-2.49	3.2	5.69	9.35	-2.49	-6.15
2ND	2.19	4.4	7.26	-2.21	-5.07	3.42	6.27	10.38	-2.85	-6.96
3RD	2.05	7.06	11.76	-5.01	-9.71	3.36	6.68	11.11	-3.32	-7.75
JUN 1ST	1.98	7.03	11.72	-5.05	-9.74	3.14	6.31	10.48	-3.17	-7.34
2ND	1.78	4.85	7.99	-3.07	-6.21	2.73	6.36	10.56	-3.63	-7.83
3RD	1.49	2.37	3.97	-.88	-2.48	2.92	5.39	8.93	-2.47	-6.01
JUL 1ST	1.5	3.02	5.01	-1.52	-3.51	2.69	4.42	7.36	-1.73	-4.67
2ND	1.45	1.64	2.71	-.19	-1.26	2.62	3.11	5.22	-.49	-2.6
3RD	1.48	1.08	1.84	.4	-.36	2.37	1.9	3.23	.47	-.86
AUG 1ST	1.44	1.46	2.56	-.02	-1.12	2.82	1.36	2.35	1.46	.47
2ND	1.37	1.67	2.93	-.3	-1.56	2.34	1.5	2.6	.84	-.26
3RD	1.32	1.46	2.58	-.14	-1.26	1.99	1.95	3.4	.04	-1.41
SEP 1ST	1.28	3.31	5.84	-2.03	-4.56	2.17	2.88	5.03	-.71	-2.86
2ND	1.06	4	7.05	-2.94	-5.99	1.79	3.46	6.05	-1.67	-4.26
3RD	.97	1.57	2.76	-.6	-1.79	1.28	3.74	6.54	-2.46	-5.26
OCT 1ST	1.02	4.03	7.09	-3.01	-6.07	1.14	3.54	6.17	-2.4	-5.03
2ND	1.04	3.09	5.43	-2.05	-4.39	1.1	3.31	5.76	-2.21	-4.66
3RD	.92	3.05	5.33	-2.13	-4.41	1.13	2.97	5.13	-1.84	-4
NOV 1ST	.82	1.38	2.41	-.56	-1.59	1	2.3	3.94	-1.3	-2.94
2ND	1.27	0	0	1.27	1.27	.82	1.85	3.13	-1.03	-2.31
3RD	3.1	.08	.13	3.02	2.97	.78	1.57	2.6	-.79	-1.82
DEC 1ST	-	1.26	1.97	-	-	-	2.79	4.36	-	-
2ND	-	1.74	2.72	-	-	3.91	1.53	2.38	2.38	1.53
3RD	-	5.25	8.21	-	-	5.61	4.53	7.07	1.08	-1.46
TOTAL	115.29	90.88	150.48	32.66	-22.29	148.68	120.84	198.85	30.63	-45.81

Table 12.16 COMPARISON OF INTAKE DISCHARGE AND IRRIGATION REQUIREMENT (2/6)

	KEDUNGSOKO BASIN YEAR 1983					KUNCIR ULO BASIN YEAR 1981				
MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W. REQUIRE-MENT II M3/SEC	IRRI. REQUIRE-MENT III M3/SEC	I - II M3/SEC	I- III M3/SEC	INTAKE DISCH-ARGE I M3/SEC	CROP.W REQUIRE MENT II M3/SEC	IRRI. REQUIRE MENT III M3/SEC	I-II M3/SEC	I-III M3/SEC
JAN 1ST	7.84	.89	1.39	6.95	6.45	5.51	3.94	6.15	1.57	-.64
2ND	9.91	2.73	4.26	7.18	5.65	5.63	3.1	4.85	2.53	.78
3RD	9.12	6.84	10.69	2.28	-1.57	5.61	.18	.27	5.43	5.34
FEB 1ST	9.9	.83	1.29	9.07	8.61	5.67	2.27	3.55	3.4	2.12
2ND	10.09	.25	.38	9.84	9.71	5.6	1.12	1.76	4.48	3.84
3RD	-	0	0	-	-	5.64	4.64	7.25	1	-1.61
MAR 1ST	9.48	2.12	3.31	7.36	6.17	5.29	.09	.14	5.2	5.15
2ND	8.45	.04	.05	8.41	8.4	4.48	1.49	2.33	2.99	2.15
3RD	7.74	1.22	1.9	6.52	5.84	3.45	1.17	1.83	2.28	1.62
APR 1ST	6.14	3.02	4.77	3.12	1.37	3.1	2.02	3.15	1.08	-.05
2ND	5.53	1.63	2.55	3.9	2.98	2.59	3.3	5.19	-.71	-2.6
3RD	5.57	1.14	1.81	4.43	3.76	2.53	2.28	3.56	.25	-1.03
MAY 1ST	5.42	.48	.75	4.94	4.67	2.61	.74	1.15	1.87	1.46
2ND	5.2	0	0	5.2	5.2	2.63	4.36	7.01	-1.73	-4.38
3RD	5.52	2.52	4.04	3	1.48	2.02	4.55	7.35	-2.53	-5.33
JUN 1ST	4.5	7.11	11.7	-2.61	-7.2	2.48	4.1	6.59	-1.62	-4.11
2ND	4.48	6.86	11.26	-2.38	-6.78	2.11	2.12	3.37	-.01	-1.26
3RD	3.56	5.82	9.55	-2.26	-5.99	2.03	.71	1.11	1.32	.92
JUL 1ST	3.41	4.75	7.82	-1.34	-4.41	1.86	2.58	4.12	-.72	-2.26
2ND	3.1	3.33	5.52	-.23	-2.42	1.77	1.53	2.42	.24	-.65
3RD	2.82	2.01	3.4	.81	-.58	1.9	1.61	2.64	.29	-.74
AUG 1ST	2.62	1.49	2.57	1.13	.05	1.72	1.47	2.51	.25	-.79
2ND	2.93	1.72	2.98	1.21	-.05	1.58	2.01	3.47	-.43	-1.89
3RD	2.29	2.23	3.89	.06	-1.6	1.17	2.23	3.88	-1.06	-2.71
SEP 1ST	1.9	3.3	5.76	-1.4	-3.86	1.26	3.51	6.13	-2.25	-4.87
2ND	1.69	3.96	6.93	-2.27	-5.24	.82	3.89	6.79	-3.07	-5.97
3RD	1.46	4.28	7.49	-2.82	-6.03	1.14	.15	.23	.99	.91
OCT 1ST	1.4	4.06	7.07	-2.66	-5.67	1.04	2.61	4.53	-1.57	-3.49
2ND	1.25	1.54	2.68	-.29	-1.43	1.02	1.53	2.64	-.51	-1.62
3RD	1.28	.35	.61	.93	.67	1.01	1.2	2.08	-.19	-1.07
NOV 1ST	1.8	1.53	2.63	.27	-.83	.75	.42	.71	.33	.04
2ND	2.72	1.26	2.13	1.46	.59	2.93	.05	.08	2.88	2.85
3RD	5.01	.36	.58	4.65	4.43	4.21	1.68	2.63	2.53	1.58
DEC 1ST	4.92	3.39	5.31	1.53	-.39	-	1.72	2.69	-	-
2ND	4.98	5.83	9.11	-.85	-4.13	-	3.63	5.67	-	-
3RD	7.58	.68	1.06	6.9	6.52	-	3.12	4.88	-	-
TOTAL	171.61	89.57	147.24	82.04	24.37	93.16	77.12	124.71	24.51	-18.31

Table 12.16 COMPARISON OF INTAKE DISCHARGE AND IRRIGATION REQUIREMENT (3/6)

KUNCIR ULO BASIN YEAR 1982

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W. REQUIRE-MENT II M3/SEC	IRRI. REQUIRE-MENT III M3/SEC	I - II M3/SEC	I - III M3/SEC
JAN 1ST	5.52	2.85	4.45	2.67	1.07
2ND	6.01	1.78	2.78	4.23	3.23
3RD	5.89	1.8	2.81	4.09	3.08
FEB 1ST	6.13	.65	1.01	5.48	5.12
2ND	5.94	3.83	5.98	2.11	-.04
3RD	5.89	2.52	3.93	3.37	1.96
MAR 1ST	4.69	0	0	4.69	4.69
2ND	3.9	.03	.05	3.87	3.85
3RD	4.11	1.92	3	2.19	1.11
APR 1ST	1.54	2.21	3.45	-.67	-1.91
2ND	3.45	2.28	3.56	1.17	-.11
3RD	3.44	1.52	2.38	1.92	1.06
MAY 1ST	3.25	3.93	6.33	-.68	-3.08
2ND	2.71	4.15	6.71	-1.44	-4
3RD	2.37	4.34	7.02	-1.97	-4.65
JUN 1ST	2.34	4.19	6.77	-1.85	-4.43
2ND	1.91	3.96	6.36	-2.05	-4.45
3RD	2.19	3.28	5.24	-1.09	-3.05
JUL 1ST	1.61	2.52	4.02	-.91	-2.41
2ND	1.76	2.03	3.25	-.27	-1.49
3RD	1.66	1.54	2.51	.12	-.85
AUG 1ST	1.38	1.35	2.28	.03	-.9
2ND	1.27	1.78	3.05	-.51	-1.78
3RD	1.06	2.24	3.87	-1.18	-2.81
SEP 1ST	.81	3.02	5.24	-2.21	-4.43
2ND	.69	3.34	5.8	-2.65	-5.11
3RD	.74	3.15	5.44	-2.41	-4.7
OCT 1ST	.69	2.6	4.46	-1.91	-3.77
2ND	.68	1.93	3.3	-1.25	-2.62
3RD	.72	1.17	1.99	-.45	-1.27
NOV 1ST	.61	.51	.85	.1	-.24
2ND	.59	.45	.7	.14	-.11
3RD	.73	2.89	4.52	-2.16	-3.79
DEC 1ST	1.85	2.47	3.85	-.62	-2
2ND	3.69	1.56	2.43	2.13	1.26
3RD	4.63	2.18	3.41	2.45	1.22
TOTAL	96.45	81.97	132.8	14.48	-36.35

KUNCIR ULO BASIN YEAR 1983

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W REQUIRE MENT II M3/SEC	IRRI. REQUIRE MENT III M3/SEC	I-II M3/SEC	I-III M3/SEC
JAN 1ST	5.88	1.83	2.87	4.05	3.01
2ND	5.71	.78	1.22	4.93	4.49
3RD	4.85	3.08	4.82	1.77	.03
FEB 1ST	5.86	.35	.54	5.51	5.32
2ND	.53	.85	1.33	-.32	-.8
3RD	5.55	0	0	5.55	5.55
MAR 1ST	5.82	2.95	4.61	2.87	1.21
2ND	5.49	.2	.32	5.29	5.17
3RD	5.01	1	1.56	4.01	3.45
APR 1ST	3.78	.83	1.3	2.95	2.48
2ND	3.53	1.78	2.79	1.75	.74
3RD	3.67	2.2	3.44	1.47	.23
MAY 1ST	3.69	.05	.08	3.64	3.61
2ND	3.54	0	0	3.54	3.54
3RD	3.76	1.38	2.16	2.38	1.6
JUN 1ST	2.19	4.69	7.52	-2.5	-5.33
2ND	3.4	4.3369	3.37	-.9369	.03
3RD	2.42	3.75	5.97	-1.33	-3.55
JUL 1ST	2.11	2.9	4.61	-.79	-2.5
2ND	1.98	2.37	3.77	-.39	-1.79
3RD	1.36	1.79	2.89	-.43	-1.53
AUG 1ST	1.23	1.52	2.55	-.29	-1.32
2ND	1.13	1.98	3.38	-.85	-2.25
3RD	1.1	2.47	4.25	-1.37	-3.15
SEP 1ST	.97	3.33	5.75	-2.36	-4.78
2ND	.79	3.68	6.36	-2.89	-5.57
3RD	.52	3.48	5.99	-2.96	-5.47
OCT 1ST	.46	2.9	4.96	-2.44	-4.5
2ND	.55	1.01	1.71	-.46	-1.16
3RD	1.43	1	1.69	.43	-.26
NOV 1ST	2.06	0	0	2.06	2.06
2ND	2.58	.4469	.08	2.1331	2.5
3RD	4.44	1.68	2.62	2.76	1.82
DEC 1ST	3.82	2.55	3.98	1.27	.16
2ND	4.08	5.06	7.91	.98	3.83
3RD	4.88	.77	1.2	4.11	3.68
TOTAL	110.17	68.99	111.74	41.18	1.57

Table 12.16 COMPARISON OF INTAKE DISCHARGE AND IRRIGATION REQUIREMENT (4/6)

WIDAS NORTH BASIN YEAR 1981

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W. REQUIRE-MENT II M3/SEC	IRRI. REQUIRE-MENT III M3/SEC	I - II M3/SEC	I- III M3/SEC
JAN 1ST	7.29	2.49	3.89	4.8	3.4
2ND	6.58	3.85	6.02	2.73	.56
3RD	5.93	.25	.4	5.68	5.53
FEB 1ST	5.92	1.89	2.95	4.03	2.97
2ND	5.22	2.17	3.39	3.05	1.83
3RD	5.55	4.22	6.59	1.33	-1.04
MAR 1ST	5.33	1.92	3	3.41	2.33
2ND	4.47	4.1	6.41	.37	-1.94
3RD	3.67	1.25	1.95	2.42	1.72
APR 1ST	3.27	1.67	2.67	1.6	.6
2ND	2.88	2.29	3.69	.59	-.81
3RD	2.32	1.44	2.28	.88	.04
MAY 1ST	2.12	0	0	2.12	2.12
2ND	2.85	3.29	5.48	-.44	-2.63
3RD	2.27	5.07	8.56	-2.8	-6.29
JUN 1ST	1.95	3.85	6.52	-1.9	-4.57
2ND	1.62	.99	1.66	.63	-.04
3RD	2.2	.29	.49	1.91	1.71
JUL 1ST	1.94	.8	1.43	1.14	.51
2ND	1.45	.47	.75	.98	.7
3RD	1.4	1.03	1.7	.37	-.3
AUG 1ST	1.24	1.15	1.96	.09	-.72
2ND	.88	1.56	2.7	-.68	-1.82
3RD	.88	1.48	2.55	-.6	-1.67
SEP 1ST	.73	2.72	4.73	-1.99	-4
2ND	.47	2.83	4.94	-2.36	-4.47
3RD	.51	.32	.53	.19	-.02
OCT 1ST	.66	1.73	2.99	-1.07	-2.33
2ND	.63	1.15	1.98	-.52	-1.35
3RD	.77	.67	1.17	.1	-.4
NOV 1ST	.51	.24	.4	.27	.11
2ND	2.8	2.02	3.15	.78	-.35
3RD	2.76	3.37	5.26	-.61	-2.5
DEC 1ST	-	2.91	4.55	-	-
2ND	-	5.28	8.25	-	-
3RD	-	2.39	3.73	-	-
T O T A L	89.07	73.15	118.72	26.5	-13.12

WIDAS NORTH BASIN YEAR 1982

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W REQUIRE MENT II M3/SEC	IRRI. REQUIRE MENT III M3/SEC	I-II M3/SEC	I-III M3/SEC
JAN 1ST	6.2	2.64	4.12	3.56	2.08
2ND	5.21	1.54	2.4	3.67	2.81
3RD	6.12	2.42	3.78	3.7	2.34
FEB 1ST	6.27	0	0	6.27	6.27
2ND	5.66	2.98	4.66	2.68	1
3RD	6.2	.34	.53	5.86	5.67
MAR 1ST	3.36	.76	1.19	2.6	2.17
2ND	3.96	.79	1.23	3.17	2.73
3RD	3.05	1.99	3.11	1.06	-.06
APR 1ST	3.26	.92	1.44	2.34	1.82
2ND	3.43	1.64	2.59	1.79	.84
3RD	2.84	.62	.97	2.22	1.87
MAY 1ST	2.6	3.47	5.75	-.87	-3.15
2ND	2.21	4.79	8.04	-2.58	-5.83
3RD	2.73	5.05	8.51	-2.32	-5.78
JUN 1ST	2.54	4.27	7.22	-1.73	-4.68
2ND	1.65	3.01	5.13	-1.36	-3.48
3RD	1.8	1.74	3.02	.06	-1.22
JUL 1ST	1.05	1.02	1.79	.03	-.74
2ND	.92	1.18	1.94	-.26	-1.02
3RD	1	1.43	2.31	-.43	-1.31
AUG 1ST	1.05	1.39	2.33	-.34	-1.28
2ND	.54	1.78	3.02	-1.24	-2.48
3RD	.47	2.2	3.76	-1.73	-3.29
SEP 1ST	.48	2.93	5.03	-2.45	-4.55
2ND	.39	3.21	5.52	-2.82	-5.13
3RD	.09	3.03	5.19	-2.94	-5.1
OCT 1ST	.28	2.52	4.29	-2.24	-4.01
2ND	.28	1.82	3.09	-1.54	-2.81
3RD	.28	.97	1.66	-.69	-1.38
NOV 1ST	.44	.48	.79	-.04	-.35
2ND	.99	3.47	5.42	-2.48	-4.43
3RD	1.96	5.08	7.94	-3.12	-5.98
DEC 1ST	-	2.7	4.21	-	-
2ND	-	2.27	3.54	-	-
3RD	-	1.64	2.56	-	-
T O T A L	79.31	78.09	128.08	7.83	-38.46

Table 12.16 COMPARISON OF INTAKE DISCHARGE AND IRRIGATION REQUIREMENT (5/6)

WIDAS NORTH BASIN
YEAR 1983

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W. REQUIRE-MENT II M3/SEC	IRRI. REQUIRE-MENT III M3/SEC	I - II M3/SEC	I- III M3/SEC
JAN 1ST	4.98	.03	.05	4.95	4.93
2ND	4.92	0	0	4.92	4.92
3RD	3.38	.64	1	2.74	2.38
FEB 1ST	5.55	.03	.04	5.52	5.51
2ND	5.43	2.7	4.22	2.73	1.21
3RD	5.04	.04	.06	5	4.98
MAR 1ST	5	4.58	7.15	.42	-2.15
2ND	6.11	.87	1.36	5.24	4.75
3RD	5.76	1.16	1.82	4.6	3.94
APR 1ST	4.97	0	0	4.97	4.97
2ND	4.7	1.49	2.33	3.21	2.37
3RD	3.82	1.46	2.28	2.36	1.54
MAY 1ST	3.98	0	0	3.98	3.98
2ND	3.79	0	0	3.79	3.79
3RD	3.74	.18	.27	3.56	3.47
JUN 1ST	2.4	3.39	5.61	-.99	-3.21
2ND	2.49	2.55	4.26	-.06	-1.77
3RD	2.47	1.46	2.49	1.01	-.02
JUL 1ST	2.21	.83	1.46	1.38	.75
2ND	1.86	.91	1.52	.95	.34
3RD	1.67	1.09	1.81	.58	-.14
AUG 1ST	1.66	1.38	2.37	.28	-.71
2ND	1.64	1.91	3.31	-.27	-1.67
3RD	1.47	2.47	4.31	-1	-2.84
SEP 1ST	1.44	3.38	5.92	-1.94	-4.48
2ND	1.32	3.76	6.59	-2.44	-5.27
3RD	1.19	3.51	6.13	-2.32	-4.94
OCT 1ST	1.12	2.84	4.94	-1.72	-3.82
2ND	.91	.47	.81	.44	.1
3RD	1.36	.32	.54	1.04	.82
NOV 1ST	6.56	.08	.12	6.48	6.44
2ND	6.56	2.42	3.79	4.14	2.77
3RD	5.19	2.47	3.87	2.72	1.32
DEC 1ST	-	4.3	6.71	-	-
2ND	-	7.71	12.04	-	-
3RD	-	1.12	1.76	-	-
TOTAL	114.69	61.55	100.94	66.27	34.26

WIDAS EXTENTION BASIN
YEAR 1981

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W REQUIRE MENT II M3/SEC	IRRI. REQUIRE MENT III M3/SEC	I-II M3/SEC	I-III M3/SEC
JAN 1ST	.38	.72	1.13	-.34	-.75
2ND	.31	2.16	3.37	-1.85	-3.06
3RD	.24	.02	.03	.22	.21
FEB 1ST	.22	.9	1.4	-.68	-1.18
2ND	.2	.87	1.36	-.67	-1.16
3RD	.22	.63	.99	-.41	-.77
MAR 1ST	.22	.1	.16	.12	.06
2ND	.18	1.84	2.87	-1.66	-2.69
3RD	.13	.94	1.47	-.81	-1.34
APR 1ST	.09	.71	1.1	-.62	-1.01
2ND	.11	.44	.69	-.33	-.58
3RD	.02	.2	.31	-.18	-.29
MAY 1ST	.04	.13	.21	-.09	-.17
2ND	.04	.21	.35	-.17	-.31
3RD	.11	.75	1.27	-.64	-1.16
JUN 1ST	.07	.89	1.52	-.82	-1.45
2ND	.09	.98	1.68	-.89	-1.59
3RD	.05	1.05	1.8	-1	-1.75
JUL 1ST	.09	1.04	1.8	-.95	-1.71
2ND	.08	.49	.84	-.41	-.76
3RD	.07	.62	1.07	-.55	-1
AUG 1ST	.08	.39	.69	-.31	-.61
2ND	.09	.22	.39	-.13	-.3
3RD	.08	.17	.31	-.09	-.23
SEP 1ST	.08	.3	.53	-.22	-.45
2ND	.08	.47	.84	-.39	-.76
3RD	.08	.13	.23	-.05	-.15
OCT 1ST	.08	.61	1.09	-.53	-1.01
2ND	.07	.64	1.14	-.57	-1.07
3RD	.07	.48	.86	-.41	-.79
NOV 1ST	.04	.28	.49	-.24	-.45
2ND	.04	.04	.08	0	-.04
3RD	.04	0	.01	.04	.03
DEC 1ST	.03	.03	.04	-	-.01
2ND	.03	.75	1.18	-.72	-1.15
3RD	.03	.58	.91	-.55	-.88
TOTAL	3.88	20.78	34.21	-16.9	-30.33

Table 12.16 COMPARISON OF INTAKE DISCHARGE AND IRRIGATION REQUIREMENT (6/6)

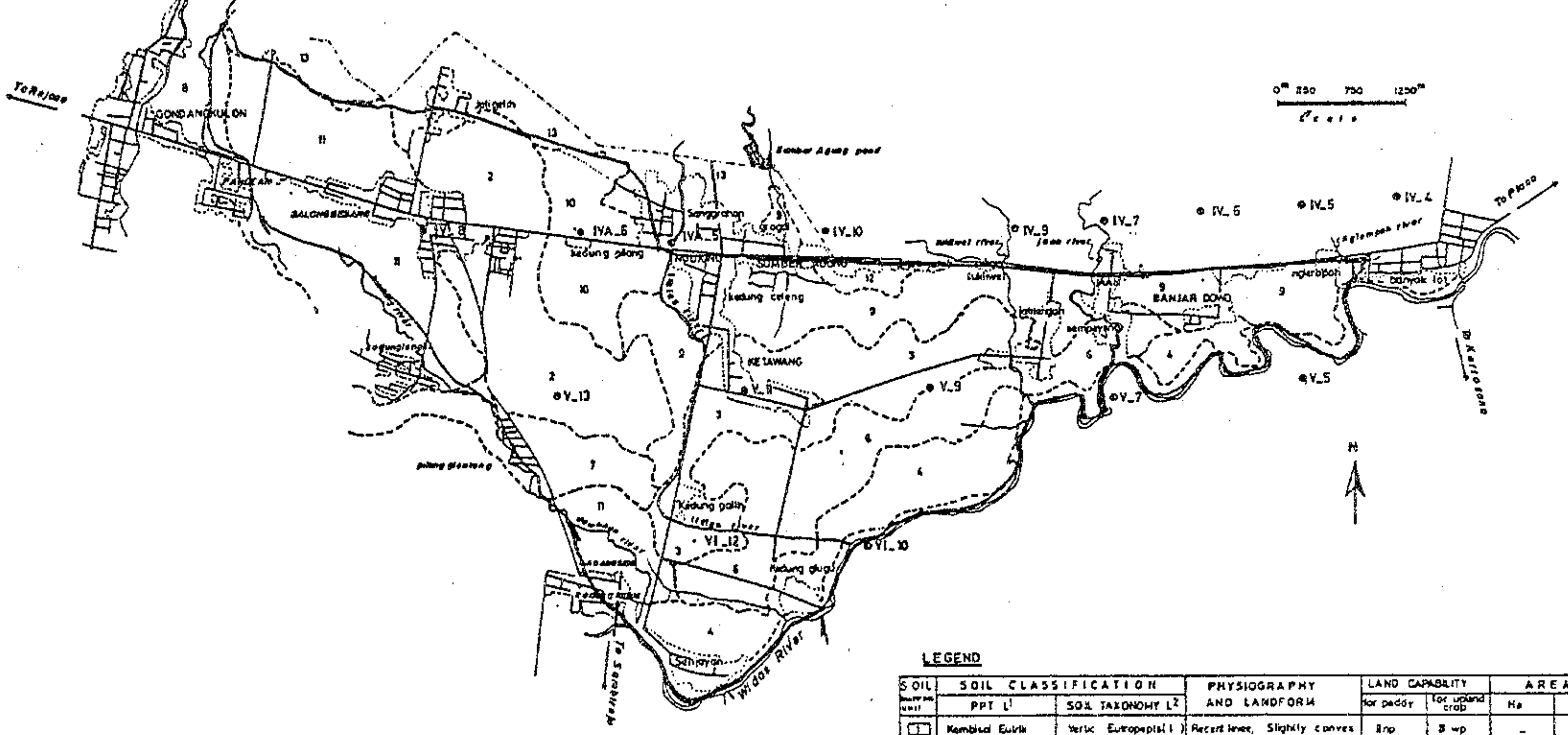
MIDAS EXTENSION BASIN
YEAR 1982

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W. REQUIRE-MENT II M3/SEC	IRRI. REQUIRE-MENT III M3/SEC	I - II M3/SEC	I- III M3/SEC
JAN 1ST	1.16	1.28	2	-.12	-.84
2ND	.92	1.28	2	-.36	-1.08
3RD	.77	.19	.29	.58	.48
FEB 1ST	.83	0	0	.83	.83
2ND	.66	1.31	2.04	-.65	-1.38
3RD	.65	1.4	2.19	-.75	-1.54
MAR 1ST	1.24	0	0	1.24	1.24
2ND	.7	.05	.08	.65	.62
3RD	.67	.46	.72	.21	-.05
APR 1ST	.55	.52	.82	.03	-.27
2ND	.33	.43	.67	-.1	-.34
3RD	.26	.15	.23	.11	.03
MAY 1ST	.27	.52	.84	-.25	-.57
2ND	.22	.52	.85	-.3	-.63
3RD	.26	.63	1.05	-.37	-.79
JUN 1ST	.23	.72	1.22	-.49	-.99
2ND	.24	.79	1.33	-.55	-1.09
3RD	.25	.83	1.41	-.58	-1.16
JUL 1ST	.12	.86	1.47	-.74	-1.35
2ND	.1	.64	1.1	-.54	-1
3RD	.1	.47	.81	-.37	-.71
AUG 1ST	.11	.29	.5	-.18	-.39
2ND	.11	.15	.27	-.04	-.16
3RD	.11	.14	.25	-.03	-.14
SEP 1ST	.11	.24	.41	-.13	-.3
2ND	.1	.31	.55	-.21	-.45
3RD	.07	.36	.64	-.29	-.57
OCT 1ST	.09	.4	.71	-.31	-.62
2ND	.08	.42	.74	-.34	-.66
3RD	.08	.36	.64	-.28	-.56
NOV 1ST	.05	.25	.44	-.2	-.39
2ND	.05	.16	.27	-.11	-.22
3RD	.07	.08	.13	-.01	-.06
DEC 1ST	.13	.04	.06	.09	.07
2ND	.3	.48	.75	-.18	-.45
3RD	.82	.61	.96	.21	-.14
TOTAL	12.81	17.34	28.44	-4.53	-15.63

MIDAS EXTENTION BASIN
YEAR 1983

MONTH	INTAKE DISCH-ARGE I M3/SEC	CROP.W REQUIRE MENT II M3/SEC	IRRI. REQUIRE MENT III M3/SEC	I-II M3/SEC	I-III M3/SEC
JAN 1ST	.47	.31	.49	.16	-.02
2ND	.91	.88	1.37	.03	-.46
3RD	.6	1.5	2.34	-.9	-1.74
FEB 1ST	.66	0	0	.66	.66
2ND	.76	.86	1.34	-.1	-.58
3RD	.86	.12	.18	.74	.68
MAR 1ST	.93	.32	.49	.61	.44
2ND	.98	.03	.04	.95	.94
3RD	.97	0	0	.97	.97
APR 1ST	.48	.46	.71	.02	-.23
2ND	.4	.16	.24	.24	.16
3RD	.26	.07	.11	.19	.15
MAY 1ST	.49	.04	.07	.45	.42
2ND	.27	.04	.06	.23	.21
3RD	.27	0	.01	.27	.26
JUN 1ST	.26	.55	.94	-.29	-.68
2ND	.29	.69	1.18	-.4	-.89
3RD	.26	.73	1.26	-.47	-1
JUL 1ST	.27	.78	1.35	-.51	-1.08
2ND	.22	.64	1.12	-.42	-.9
3RD	.24	.45	.78	-.21	-.54
AUG 1ST	.25	.3	.52	-.05	-.27
2ND	.2	.17	.29	.03	-.09
3RD	.16	.15	.25	.01	-.09
SEP 1ST	.11	.23	.4	-.12	-.29
2ND	.1	.3	.52	-.2	-.42
3RD	.1	.35	.6	-.25	-.5
OCT 1ST	.1	.38	.66	-.28	-.56
2ND	.1	.3	.52	-.2	-.42
3RD	.1	.27	.46	-.17	-.36
NOV 1ST	.07	.13	.23	-.06	-.16
2ND	.12	0	0	.12	.12
3RD	.37	0	0	.37	.37
DEC 1ST	.49	.05	.08	-	.41
2ND	.58	1.05	1.64	-.47	-1.06
3RD	.83	.75	1.17	.08	-.34
TOTAL	14.53	13.06	21.42	1.03	-6.89

Fig. 12.1 SOIL AND CAPABILITY MAP IN GONDANG AREA

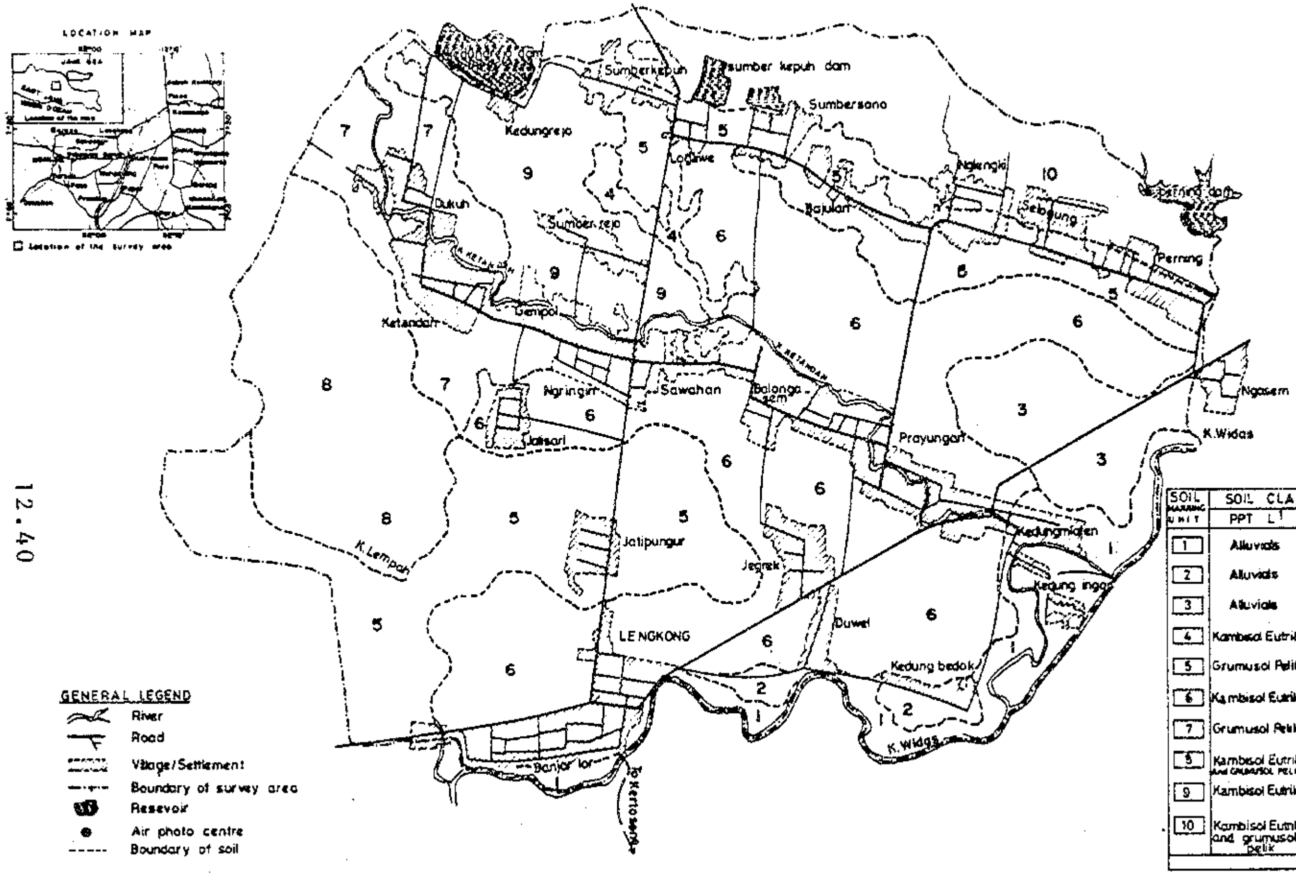


LEGEND

SOIL mapping unit	SOIL CLASSIFICATION PPT L1	SOIL TAXONOMY L2	PHYSIOGRAPHY AND LANDFORM	LAND CAPABILITY for paddy	for upland crop	AREA Ha	%
1	Kambisol Eutrik	Vertic Eutropepts (1)	Recent levee, Slightly convex 3%	[illegible] np	[illegible] wp	-	-
2	Kambisol Eutrik	Vertic Eutropepts (2)	Plain, Almost level Undulating and slightly dissected 0_3%	[illegible] n	[illegible] wnp	295	14.6
3	Kambisol Eutrik	Vertic Eutropepts (3)	Plain, Almost level Undulating and slightly dissected 0_3%	[illegible] npa	[illegible] wp	299	14.8
4	Kambisol Eutrik	Vertic Tropaquepts (4)	Plain, Level 0_2%	[illegible] npa	[illegible] wp	303	15.0
5	Kambisol Eutrik	Vertic Tropaquepts (6)	Plain, Level 0_2%	[illegible] np	[illegible] wp	-	-
6	Kambisol Eutrik	Vertic Tropaquepts (5)	Plain, Almost Level Undulating and slightly dissected 0_3%	[illegible] npa	[illegible] wp	242	12.0
7	Grumusol Pelik	Typic Pellusterts (8)	Plain, Level 0_2%	[illegible] np	[illegible] wp	62	3.1
8	Grumusol Pelik	Typic Pellusterts (12)	Plain, Level 0_2%	[illegible] np	[illegible] wp	-	-
9	Grumusol Pelik	Typic Pellusterts (7)	Plain, Almost Level Slightly dissected 0_3%	[illegible] n	[illegible] wnp	324	16.1
10	Grumusol Pelik	Typic Pellusterts (10)	Plain, Almost Level Slightly dissected 0_3%	[illegible] n	[illegible] wnp	126	6.3
11	Grumusol Pelik	Typic Pellusterts (13)	Plain Level 0_2%	[illegible] npa	[illegible] wp	324	16.1
12	Grumusol Pelik	Typic Pellusterts (9)	Plain, Sloping terrain 2_5%	[illegible] np	[illegible] wp	39	1.9
13	Grumusol Pelik	Typic Pellusterts (11)	Plain, Sloping terrain 2_5%	[illegible] np	[illegible] wp	-	-
14	Kambisol Eutrik	Fluvaquentic Eutropepts (14)	Plain, Level 0_3%	[illegible] nap	[illegible] p	-	-
15	Kambisol Eutrik	Fluventic Ustropepts (15)	Plain, Almost level, Slightly dissected 0_3%	[illegible] np	[illegible] wnp	-	-
16	Kambisol Eutrik	Fluventic Ustropepts (16)	Plain, Level 0_2%	[illegible] npa	[illegible] wp	-	-
					TOTAL	2,014	100

L1 : SOIL CLASSIFICATION STANDARD of INDONESIA
L2 : SOIL CLASSIFICATION STANDARD of USDA
L3 : No of SOIL SERIES

Fig. 12.2 SOIL AND LAND CAPABILITY MAP
IN LENGKONG AREA

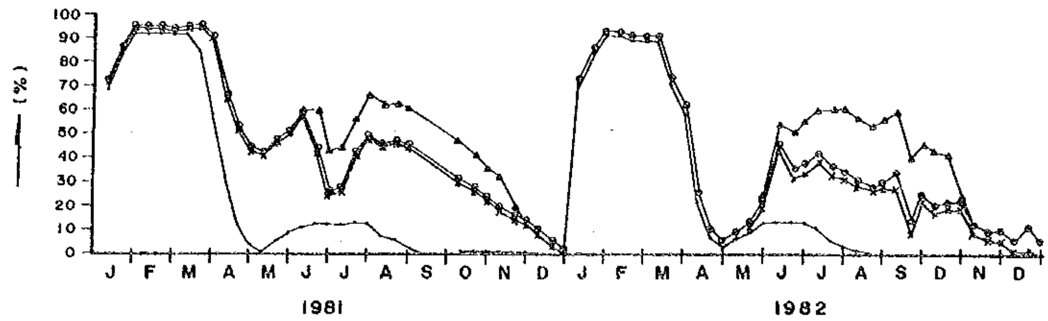


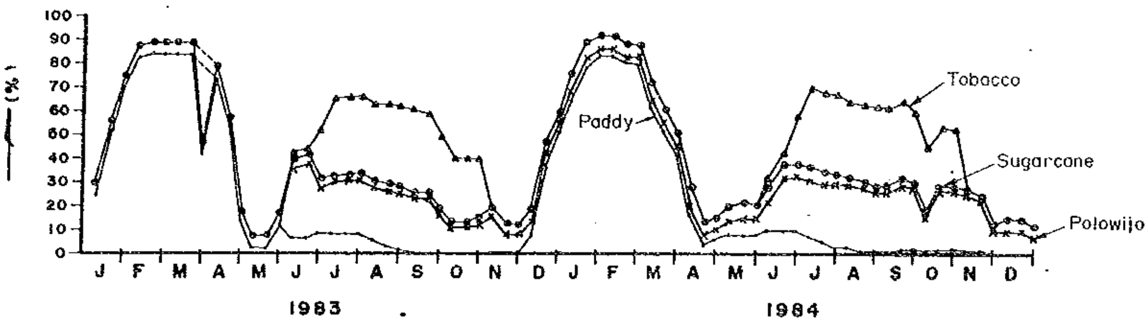
0 200 400 600 800 1000 m
scale

N

GENERAL LEGEND
River
Road
Village/Settlement
Boundary of survey area
Resevoir
Air photo centre
Boundary of soil

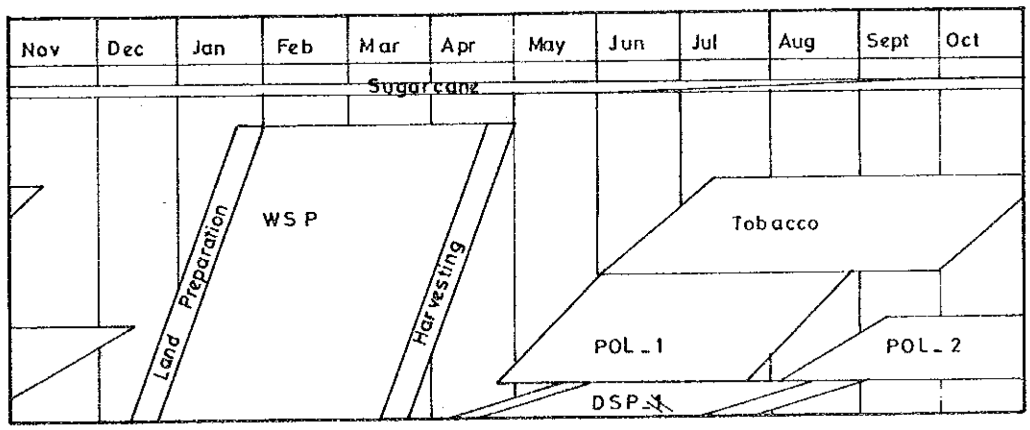
SOIL MAPPING UNIT	SOIL CLASSIFICATION PPT L[1]	SOIL TEXANOMY L[2]	PHYSIOGRAPHY And LANDFORM	PARENT MATERIAL	LAND CAPABILITY FOR PADDY	FOR UPLAND CROP	AREA Ha	%
1	Alluvials	Vertic Fluvaquents (3)	Old levee, 1 _ 2%	Alluvium	II nap	III wp	8	0.5
2	Alluvials	Typic Ustifluvents (1)	Recent levee, slightly convex, 2_3 %	Alluvium and Colluvium	II np	III wnp	2	0.1
3	Alluvials	Typic Ustifluvents (2)	Alluvial valley	Alluvium mixed with vulcanic product	II nap	III wp	78	4.9
4	Kambisol Eutrik	Vertic Tropaquepts (7)	Alluvial valley 2_3 %	Alluvium mixed with vulcanic product	II nap	III wp	199	12.4
5	Grumusol Pelik	Typic Pellusterts (4)	Level plain, 0_1 %	Alluvium, limestone devided	II np	III wp	312	19.4
6	Kambisol Eutrik	Vertic Eutropepts (6)	Level plain, 0_1 %	Alluvium	II np	III wp	464	28.9
7	Grumusol Pelik	Typic Pellusterts (5)	Almost level slightly dissected plain, 3_5 %	Alluvium and Colluvium	II np	III wp	89	5.5
8	Kambisol Eutrik and grumusol pelik	Vertic Eutropepts and Typic Pellusterts (4/6)	Level plain, 0_1 %	Alluvium	II np	III wp	176	11.0
9	Kambisol Eutrik	Vertic Fluvaquents and Vertic Tropaquepts (3/7)	Alluvial valley, 2_3 %	Alluvium	II nap	III wp	122	7.6
10	Kambisol Eutrik and grumusol pelik	Vertic Eutropepts and Typic Pellusterts (5/6)	Almost level slightly dissected plain, 3_5 %	Alluvium and Colluvium devided from limestone	II np	III dp		
					TOTAL		1,605	100.00





PRESENT CROPPING STATUS IN IRRIGATION UNITS
RELATED TO WIDAS EXTENTION AREA

Source : Laporan Bulan Keadaan Irigasi



WSP : Wet season paddy
DSP : Dray season paddy
POL_1: Polowijo Crops_1
POL_2: Polowijo Crops_2

Fig: 12.3 PRESENT CROPPING PATTERN
WIDAS EXTENSION AREA

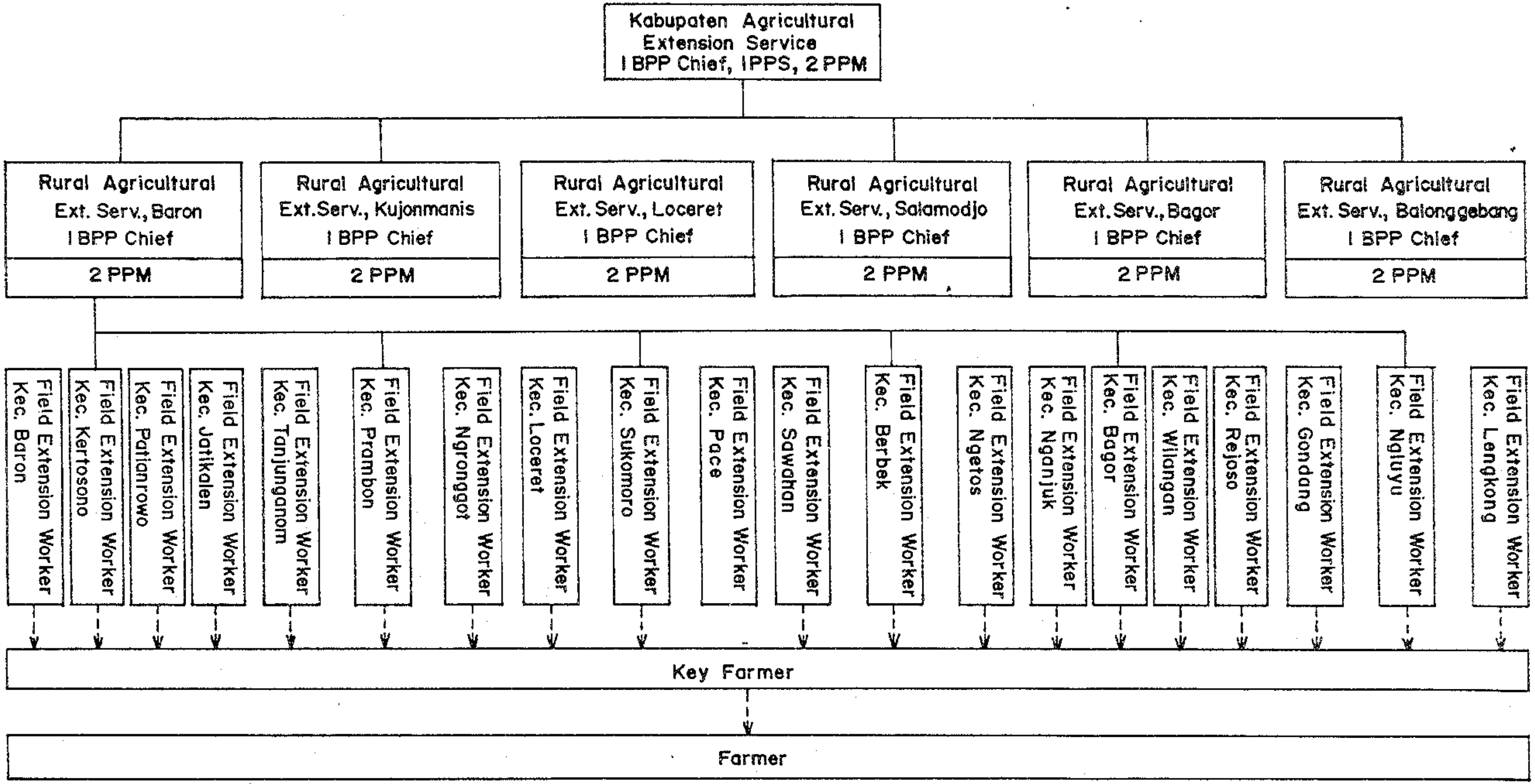


Fig. 12.4 ORGANIZATION OF KABUPATEN AGRICULTURAL EXTENSION SERVICE

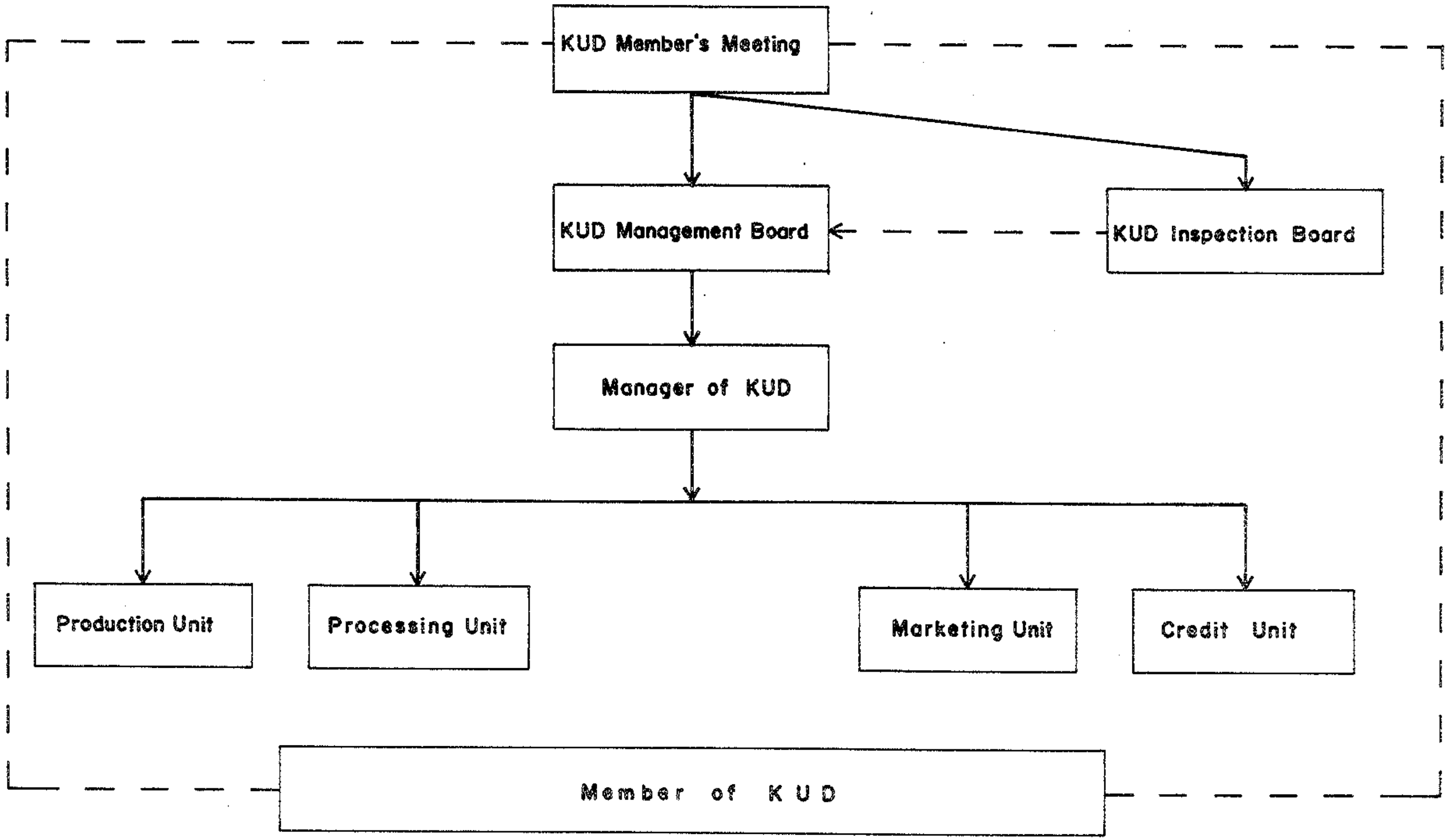


Fig.12.5 THE EXISTING ORGANIZATION CHART OF KOPERASI UNIT DESA/KUD (VILLAGE UNIT COOPERATIVE)

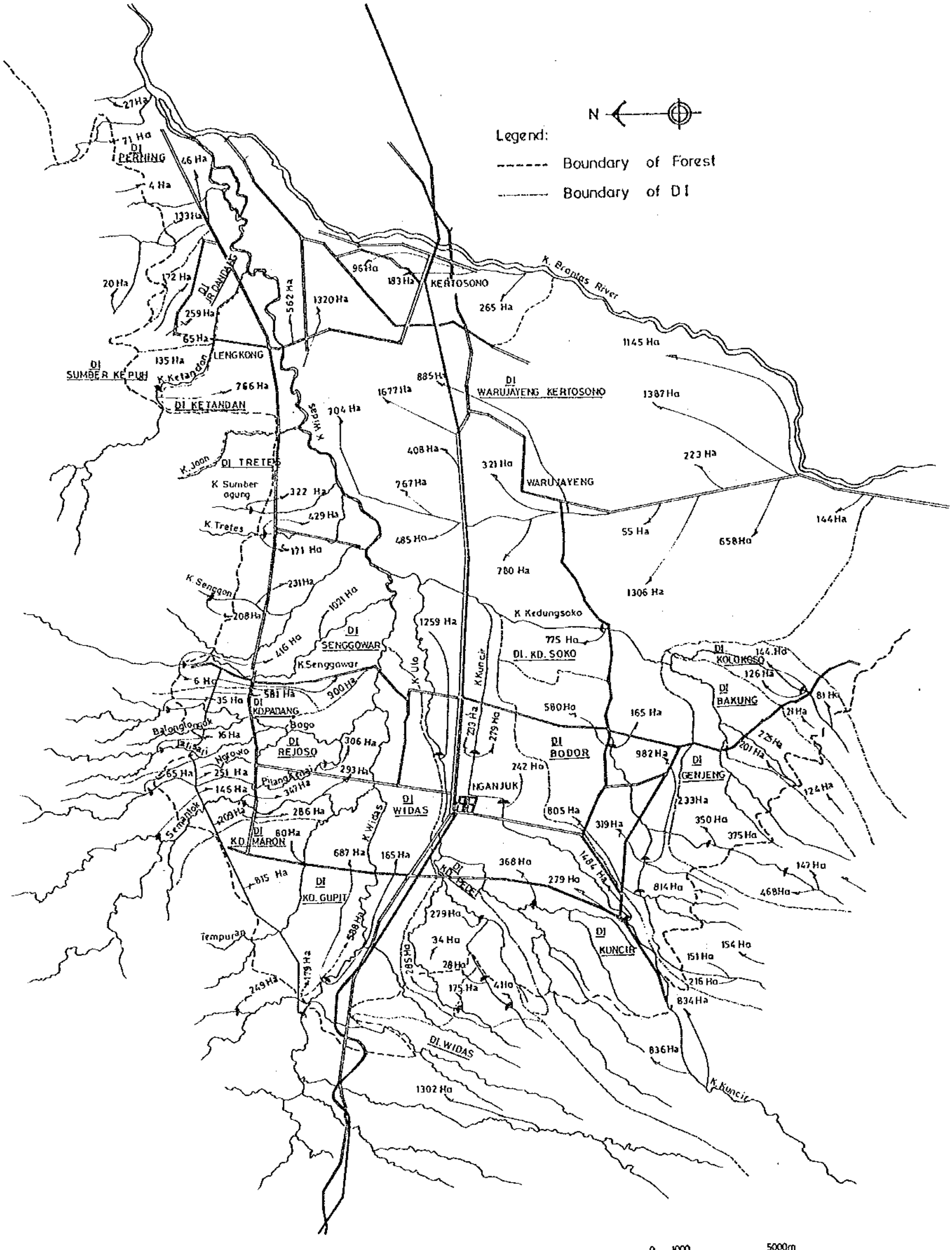
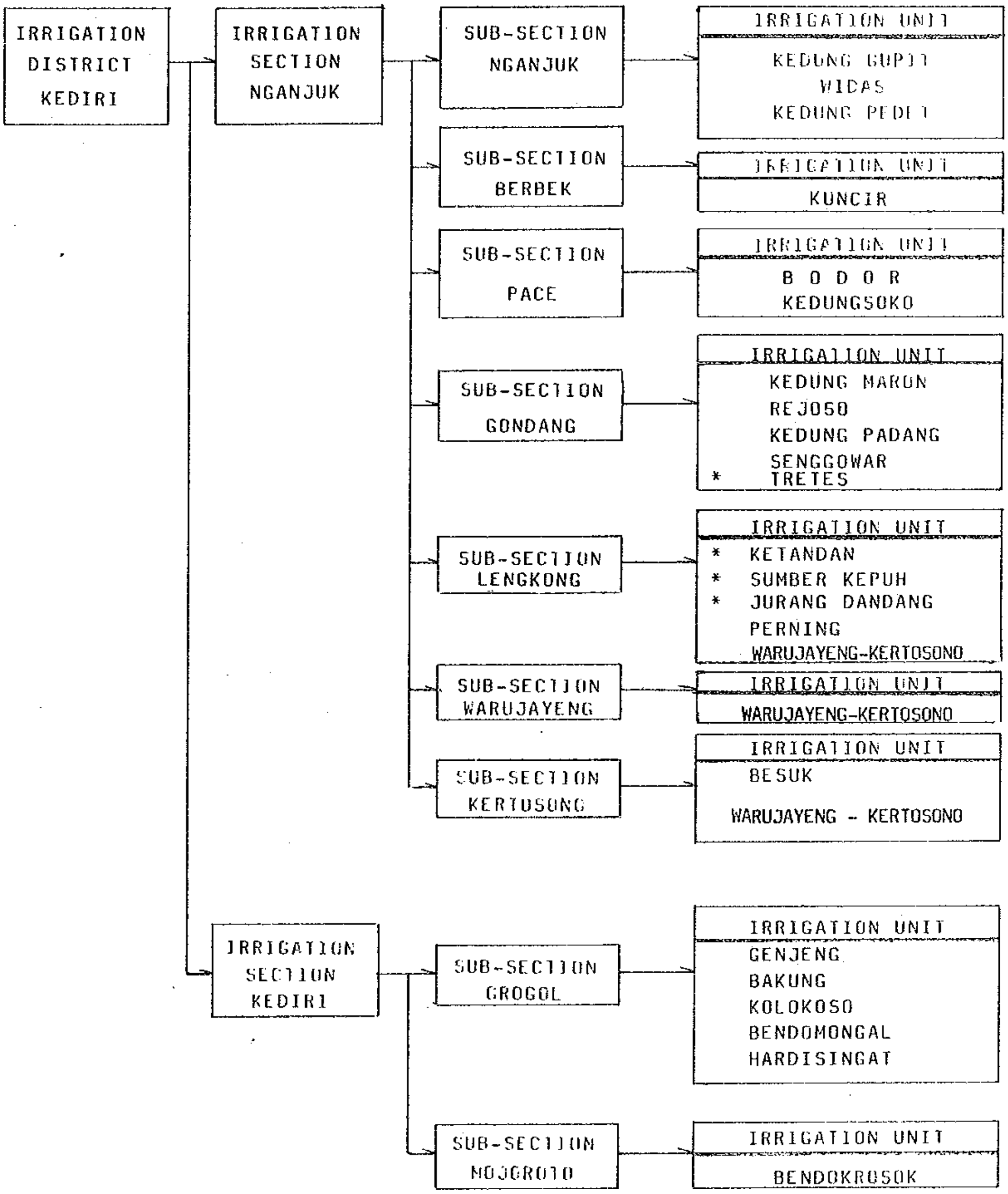


Fig. 12.6 IRRIGATION NETWORKS IN WIDAS BASIN.



* : Irrigation units related to Project Area.

Fig. 12.7 IRRIGATION ORGANIZATION ON WIDAS BASIN

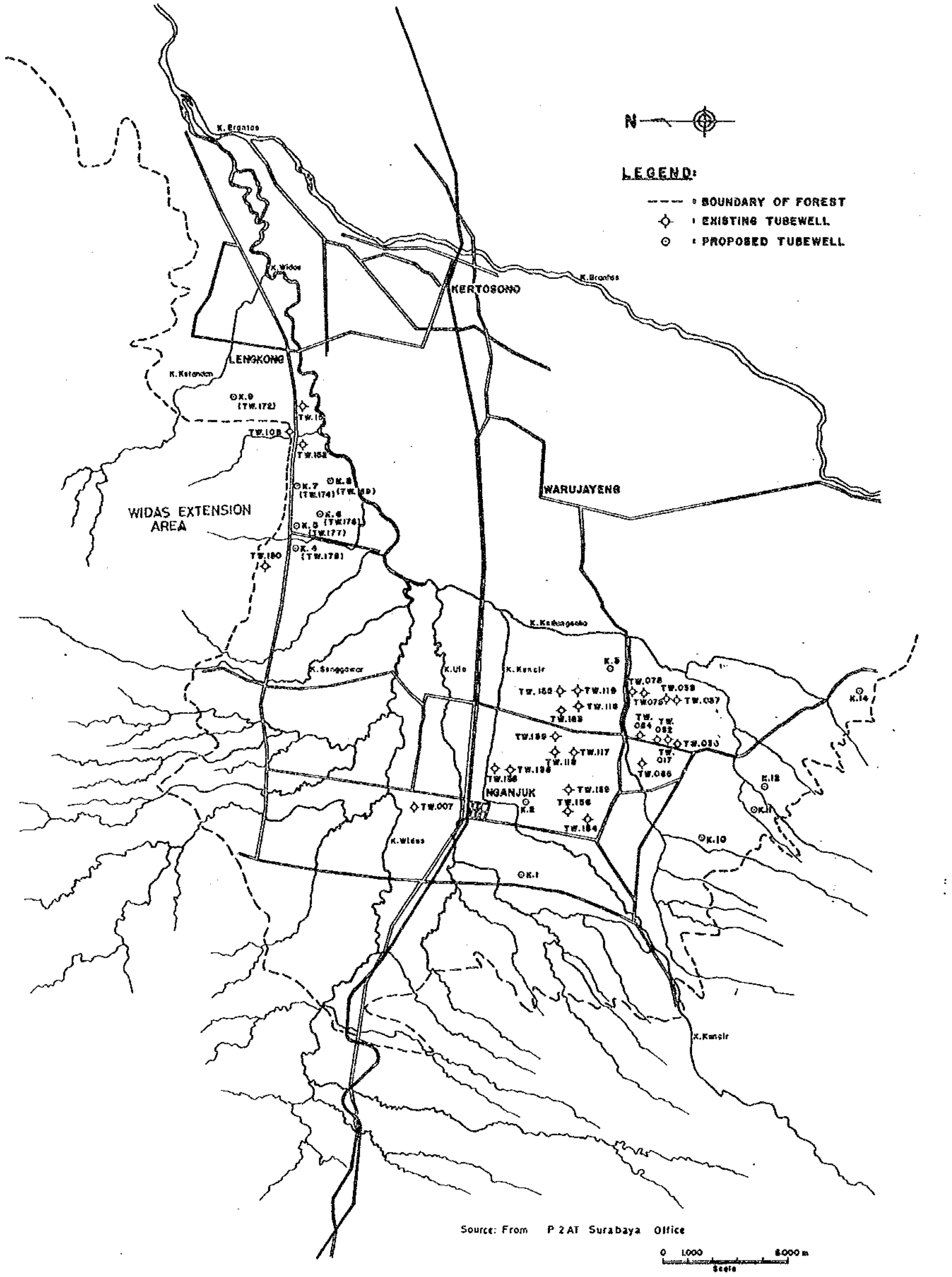


Fig. 12.8 TUBEWELL DISTRIBUTION IN WIDAS BASIN

CHAPTER 13 PROPOSED AGRICULTURAL DEVELOPMENT

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13. PROPOSED AGRICULTURAL DEVELOPMENT PLAN

13.1 General

13.1.1 Basic objectives of development

The objective for agriculatural and irrigation development in the project Area is to achieve the equitable development among areas in the Widas river basin. The concept of equitable development is attributed to the government's effort to narrow the social and economic gap between Java island and other Outer islands. Within Java island, there remains less developed areas like the Widas extension area. Sharp contrast between the developed area like the Warujayeng-Kertosono area and the less developed area like Widas Extension Area within the same basin is not socially acceptable and should not be left as it is.

In the frame work of agricultural development plan examined in PART-II study the achievement of regional equity in the Widas basin is defined as the improvement of farmer's living standard in the Project Area by increasing agricultural production. For the purpose of increasing agricultural production, the following items are taken into account in the Project Area:

- To raise rice production keeping pace with the demand growth since Indonesia has already achieved the self-sufficiency of rice.

- To promote production of polowijo crops and estate crops based on the government policy of crop diversification.

13.1.2 Strategy for development

Insufficient irrigation water supply is the biggest constraint to the agriculture in the Widas Extension Area. Therefore, the following strategy are formulated in order to achieve the basic objectives.

1) Unit yield of wet season paddy should be improved and stabilized through proper supplemental irrigation and introduction of proper farming.

2) Unit yield of dry season polowijo should be improved and stabilized to the maximum extent within the limitation of water to be made newly available.

3) In order not to generate regional inequity within the Widas Extension Area, as much area as technically possible should be covered by the Project.

13.2 Future Land Use

As explained in Chapter 12, the irrigation facilities in the area have been poorly developed, although the Widas Extension Area is classified as irrigated area. With the project, the Widas Extension Area will become an irrigated area in its true meaning. By construction of irrigation facilities, farm lands of 155 ha will be occupied by the facilities. Upland field will be irrigated. Therefore the future land use with the Project condition will be as follows;

Land use category	Present Condition (ha)	Future (condition) with the Project (ha)
1) Farm land	3,557	3,403
Paddy field	2,758	2,955
Paddy field by groundwater	448	448
Upland field	351	-
2) House yard	527	527
3) Settlement	742	742
4) Others	434	434
5) Right of way	-	154
Total	5,260	5,260

13.3 Proposed Cropping Pattern

In formulation of cropping pattern, the following basic principles are assumed. These principles were consulted with various offices and generally accepted by them.

1) The area of dry season paddy is to be kept as the present level and priority is to be given to the dry season polowijo.

2) The area of dry season polowijo must be maximized within the limit of available water. Cultivitation of maized and soybean is extended, since these crops are major protein source of Indonesia people and farmers are accustomed with their cultivation. Red onion which is cultivated in the Widas north area with irrigation condition is introduced.

3) The area of sugarcane is to be kept as it is.

4) Although tobacco is a profitable crop and needs little irrigation water, the area of tobacco is kept as it is, since the government has no itension to promote tobacco production by public fund.

5) The cropping pattern should conform with the existing social traditions and be acceptable to the farmers.

As the basic cropping pattern, the following are conceived;

(1) Paddy - Paddy - Polowijo
(2) Paddy - Polowijo - Polowijo
(3) Paddy - tobacco (not irrigated)
(4) Sugarcane

Proportion of the above four basic pattern are studied within the limitation of available water, and the following pattern is adopted;

	Without Project	With Project
Paddy		
Wet	2,707	2,800
Dry	269	269
Maize		
Irrigated	-	880
Non-Irrigated	761	710
Soybean		
Irrigated	-	880
Non-Irrigated	709	710
Red onion		
Irrigated	-	606
Sugarcane		
Irrigated	-	102
Non-Irrigated	102	-
Tobacco	775	775
Total	5,323	7,732

Fig.13.1 shows proposed cropping pattern in the project area.

13.4 Proposed Farming Practice

Proper farming practices are the most essential factor for realization of the full exploitation of the agricultural potential in the area. For the purpose, present farming practices were assessed, and constraints which have hindered increasing unit yield of agricultural crops were clarified as mentioned previously. Countermeasures for the present constraints were carefully studied.

The proposed design criteria for farm inputs and farming practice for agricultural crops is summarized in Table 13.1 and is described as follows:

(1) Paddy

Variety and Seed Treatment

Early-matured high yielding varieties like IR 36 is proposed to be used. The seed requirement is recommended to be 35 kg per ha. It is recommended that the seeds have to be certificated extension seeds and be selected by using a solution of 1.13 specific gravity before pregermination. The pre-germination practice is recommendable for increasing the germination percentage.

Nursery Preparation

The size of nursery bed in about 1/20 of paddy field. Fertilization is essential. A dosage of 5 kg of urea is recommended. The nursery period is 20 days after seeding.

Land Preparation

The ploughing is carried out by animal power at least 10 days before transplanting. Harrowing and puddling works are also carried out by animal power.

Transplating

Transplanting is undertaken with a space of 30 cm x 15 cm, equivalent to 22.2 of hills per m^2. 2 to 3 seedlings per hill is recommendable for planting. The irrigation water should be drained just before transplanting so as to accelerate vigorous tillering under shallow transplanting. Irrigation water is supplied to the field againafter rooting.

Fertilization

Proper application of fertilizer is essential for full exploitation of agricultural potential under irrigated condition. The soils of the area are generally low in plant nutrient. The chemical elements, such as nitrogen, phosphate and pottasium, have to be supplemented by fertilizers. Considering the soil condition and target yield of paddy, fertilizer requirement was determined. The total fertilizer requirement for sustaining the targer yields is designed to be 300 kg/ha of urea, 140 kg/ha of TSP and 140 kg/ha of KCL. Split application of fertilizer is recommended for effective use of fertilizer. The basic fertilizer application is 100 kg/ha of urea, 140 kg/ha of TSP and 90 kg/ha of KCL when field preparation is practiced. Top dressing is made in 3 times. About 100 kg of urea is applied at the initial tillering stage or about 15 days after transplanting and at the initial young panicle formation stage or about 45 days after transplanting. KCL is applied about 50 kg/ha at the heading period.

Weeding

After transplanting, weeding is carried out twice, depending on the status of weed growth. For effective weeding, it is recommended that use of herbicides is introduced to the area.

Plant Protection

With regard to the plant protection, intensive application of pesticides is required for control of worms, plant hoppers and stem borrer. Considering the life-cycle of these insects, 3 to 4 ℓ/ha of pesticides are required for twice to three times applications during one cropping season. In selecting suitable insecticides and pesticides, chemical toxicity which directly or indirectly affects the human-being should be taken into consideration.

It is recommended that plant protection works be carried out in a systematic way through the farmer's cooperatives.

Harvesting

Harvesting is carried out manually, and harvested paddy is dried on the ground. In future, introduction of artificial dryers will be considered because much of the harvested grain is presently damaged by unexpected rains.

(2) Polowijo Crops

As for polowijo farming, the present primitive methods have to be improved with use of improved varieties, fertilizers and agro-chemicals under irrigated condition.

The design criteria of the proposed farming practices for polowijo crops is as shown in Table 13.2 and 13.3.

The proposed farm inputs and labour requirement are given in Table 13.4.

13.5 Anticipated Yield and Production

13.5.1 Anticipated yield

Unit yield of crops are estimated both for future without and with project conditions.

Without Project

From the standpoint of the historical trend of agricultural production, unit yield and agricultural economy of the area, significant improvement can not be expected unless a new irrigation project is implemented. The production techniques such as new varieties, more efficient use of fertilizers, prevention of pests and diseases as well as water management techniques are always changing and progressing but the effect of these changes is generally insignificant under rainfed and unstable irrigated condition. Therefore, the anticipated yield of crops under without project condition are estimated to be the same as those under present condition.

With Project

Anticipated unit yields of crops with project condition are estimated on the basis of the experimental data, results of farmer's interview survey and the actual yield record within the well irrigated lands in and around the area. (see Tables 13.5, 13.6 and 13.7.)

The anticipated crop yields with and without projects conditions are estimated below:

(Unit : ton/ha)

Crops	Without Project	With Project
Paddy	3.91	5.5
Maize	2.23	4.0
Soybeans	0.68	1.4
Red onion	-	8.0
Sugarcane	56.9	90.0
Tobacco	2.89	2.89

For the achievement of anticipated yield, optimum application of farm inputs as well as proposed farming practices is essential with effective water management.

The yield will be expected to increase gradually from the present level and will reach the target yield of crops in the 3rd year after the completion of the irrigation facilities.

13.5.2 Crop production

Total crop production at the full development stage is estimated by multiplying the anticipated yield with the future cultivation area. The crop productions under both with and without project condition are estimated as shown in Table 13.8 and summarized below:

(Unit : ton)

Crops	With Project	Without Project	Increment
Paddy	16,880	11,634	5,246
Maize	5,103	1,697	3,406
Soybeans	1,715	482	1,233
Sugarcane	9,180	5,804	3,376
Tobacco	2,240	2,240	0
Red onion	4,848	0	4,848

The expected annual increment of crop production as a result of project would be about 5,246 tons of paddy, 3,406 tons of maize and 1,233 tons of soybeans.

13.6 Marketing and Price Forecast

13.6.1 Marketing

Although the rice surplus from the project area can not be expected at present, the rice surplus will be estimated to be achieved in the near future, due to completion of the Project. The expected amoutn of rice surplus will reach up to around 2,350 ton in 1993. This rice surplus will be not only distributed in the local market, but also supplied to the deficient area of rice, especialy Outside Java.

Compared to the population ratio of the Project area to Kab. Nganjuk (5.2%), polowijo crops remains at low level of production. (See table 2.13 and 13.8). This fact has partly resulted from poor marketability condition in the Project area. Based on crops diversification promoted by the government policy, the improvement of local market condition will activate polowijo production which will be expected to increase owing to the Project.

13.6.2 Price forecast

In order to evaluate the expected project benefit, economic farm gate price of farm products and inputs in the future are forecasted by referring to Price Prospect for Primary Commodities issued by the World Bank. With respect to red onion, present financial farm gate price is adopted as economic price. The detailed results are shown in Annex 6.

Financial farm gate prices of farm products and inputs for the farm budget survey are estimated to be the same as present prices of them. Since future price movement is an unknown factor, the monthly averages of the local market prices in 1984 are adopted conservatively for determination of the financial price.

13.7 Irrigation Benefit

Annual irrigation benefit to be expected is defined as the difference of net incomes from crops between with project and without project conditions. Based on the estimate gross income and production cost at the projected 1990 economic prices at 1985 constant value primary profit per ha for each crop is calculated on both with and without conditions. The primary profits of each crops both with and without condition is shown in ANNEX 6.

Multiplying primary profit per ha of each crop with present or proposed crop area, annual total profits accured from agricultural production is estimated on both with and without project condition. Since red onion is not planted in the Project area at present, future total profits of red onion is counted as the benefit for red onion. The detailed results are shown below:

Crop	With Project			Without Project			
	Area (ha)	Primary Profit (10^3Rp/ ha)	Total Profit (10^6Rp/ ha)	Area (ha)	Primary Profit (10^3Rp)	Total Profit (10^6Rp)	Benefit (10^6Rp)
Wet Season Paddy	2,800	877.1	2,456.0	2,707	603.8	1,634.5	821.5
Dry Season Paddy	269	877.1	236.0	269	603.8	162.4	73.6
Maize (Irrigated)	880	455.0	391.6	761	247.7	188.5	203.1
Soybean (Irrigated)	880	312.9	275.3	709	70.1	49.7	225.6
Sugarcane	102	1,270.1	129.5	102	511.3	52.2	77.3
Maize (Non-irrigated)	710	247.7	175.9				175.9
Soybean (Non-irrigated)	710	70.1	49.8				49.8
Red Onion	606	1,880.4	1,139.5				1,139.5
Total							2,766.3

13.8 Farm Economy

In order to assess the irrigation project from farmer's financial point of views, farm budget in the future condition is examined for comparison with present farm budget survey.

After the implementation of irrigation project, an increase of cropping intensity will expand cropping area for paddy and polowijo crops. As a result, drastic increase on farm income in the future with project condition can be expected in the farmer. On the other hand, farm income in the future without project condition will remain unchanged from the present condition. The farm budget in the future with project condition is prepared as shown in Table 13.9 and outlined below:

Item		Without Project (10^3 Rp)	With Project (10^3 Rp)
I.	Gross Income	705	2,596
	1) Farm income	425	2,316
	2) Non-farm income	280	280
II.	Expenditure	696	1,772
	1) Production cost	206	862
	2) Living expenses	490	910
III.	Net Reserve	8	824
IV.	Net Farm income	219	1,454

Farm income with with project will be expected to become about 3.7 times of that without project condition. Net farm income with project will be expected to increase 6.6 times. Annual net reserve will increase from 8,000 Rp to 824,000 Rp. at full development stage.

Table 13.1 DESIGN CRITERIA OF PROPOSED FARMING PRACTICES FOR PADDY

1.	Varieties	IR 36
2.	Growing period	110 - 120 days
3.	Amount of seed	35 kg/ha
4.	Nursery period	15 - 20 days
5.	Area of nursery bed	1/20 of paddy field
6.	Land preparation	One time of ploughing and 2 times of harrowing / puddling
7.	Planting method	Transplanting
8.	Planting density	30 cm x 15 cm, 3 seedlings / hill
9.	Planting depth	3 cm from the surface
10.	Fertilization	
	- Nursery bed	5 kg of Urea
	- Paddy field	295 kg of Urea per ha 140 kg of TSP per ha 140 kg of KCL per ha
	Time in paddy field	
	- All TSP	Basic dressing at land preparation time
	- 1/3 of Urea	Basic dressing at land preparation
	- 1/3 of Urea	First top dressing at 2 weeks after transplanting time
	- 1/3 of Urea	Second top dressing at 45 days after transplanting time
	- 2/3 of KCL	Basic dressing at land preparation
	- 1/3 of KCL	Top dressing at heading period
11.	Weeding	One time at about 25 - 30 days after transplanting
12.	Application of chemicals	- Herbicide 3 kg/ha - Pesticides 4 ℓ /ha
13.	Harvesting	by sickle

Table 13.2 DESIGN CRITERIA OF PROPOSED FARMING PRACTICES FOR POLOWIJO CROPS

Farming Practices	Maize	Soybeans
1. Varieties	Arjuno, Hibrida C_1 and Hibrid series	No. 29, Orba
2. Growing period	90 - 100 days	90 - 110 days
3. Amount of seed	30 kg/ha	30 kg/ha
4. Land preparation	2 times of ploughing and harrowing	-
5. Planting method	Direct seeding	Straight sowing
6. Planting density	25 cm x 75 cm	30 cm x 20 cm
7. Fertilization		
- Basic dressing	80 kg/ha of Urea 180 kg/ha of TSP 245 kg/ha of KCl	35 kg/ha of Urea 50 kg/ha of TSP 40 kg/ha of KCl
- Top dressing	80 kg/ha of Urea	35 kg/ha of Urea
8. Weeding	2 times at 10th and 30th day after seeding	2 times at 20th and 40th day after seeding
9. Application of chemicals		
- Pesticide	3 lit/ha	6 lit/ha

Table 13.3 DESIGN CRITERIA OF PROPOSED FARMING PRACTICES FOR RED ONION

Farming Practices	Red Onion
1. Varieties	65% Bauji, 26% Ampenan, and 9% Bima
2. Growing period	60 - 90 days
3. Amount of seed	600 - 700 kg/ha
4. Land preparation	One time of ploughing
5. Planting method	Direct seeding
6. Planting density	10 cm x 20 cm
7. Fertilization	300 kg/ha of Urea 200 kg/ha of TSP 150 kg/ha of KCl 20 m^3/ha of manure 2 l/ha of foliaceous fertilizer
8. Weeding	3 times of 20th and 40th day after planting
9. Application of chemicals	20 kg/ha of fungicide 20 l/ha of insecticide

Source : Vegetables Research Office in Malang.

Table 13.4 FARM INPUTS, LABOUR AND ANIMAL POWER REQUIREMENTS PER HECTARE (WITH PROJECT)

No.	Items	Kinds of Crops				
		Paddy	Maize	Soybean	Red-Onion	Sugar-cane
1)	Farm inputs					
	a) Seed (kg)	35	30	30	600	/1 2,200
	b) Fertilizers					
	- Urea (kg)	300	160	70	300	600
	- TSP (kg)	140	180	50	200	100
	- KCL (kg)	130	245	40	150	-
	- Manure (m3)	-	-	-	20	-
	- Foliaceous fertilizer (ℓ)	-	-	-	2	-
	c) Agro-chemicals					
	- Herbicides (kg)	3	-	-	-	-
	- Pesticides (ℓ)	4	3	6	-	-
	- Fungicides (kg)	-	-	-	20	-
	- Insecticides (ℓ)	-	-	-	20	-
2)	Labour requirement (man-day)					
	- Nursery preparation	15	-	-	-	-
	- Land preparation	30	16	16	220	-
	- Seed selection	-	-	-	10	-
	- Planting	-	-	-	60	-
	- Transplanting (sowing)	37	17	9	-	-
	- Irrigation	7	2	3	150	
	- Fertilizing	6	4	4	30	
	- Weeding	27	16	-	100	
	- Spraying	6	6	12	40	-
	- Harvesting/threshing	106	13	27	60	-
	- Drying	27	-		-	-
	Total	261	74	71	670	800
3)	Animal power requirement (Animal-day)	21	19	0	-	-

Note: /1 : Sugarcane Unit : stalk

Table 13.5 YIELD RECORD OF PADDY IN FOUR KECAMATAN IN KABUPATEN NGANJUK

(Unit: paddy, ton/ha)

Kecamatan	1979	1980	1981	1982	1983	Avwrage
Prambon	5.53	5.06	5.61	6.01	6.09	5.66
Ngronggot	5.58	5.13	5.61	6.16	6.11	5.72
Patianrowo	5.56	5.26	5.46	5.63	5.58	5.50
Tanjunganom	6.11	5.41	5.64	6.25	6.22	5.93

Source : Agriculture Service Office in Kabupaten Nganjuk
Remark : These figures include low land rice and upland rice

Table 13.6 HIGH YIELD RECORDS OF PADDY, IR-36

(Unit : Paddy, ton/ha)

Kecamatan	High Yield Records
Tulungagung	5.7
Kedungwaru	5.7
Kauman	6.1
Gondang	5.9
Pakel	5.3
Besuki	5.7
Campurdarat	5.7
Bandung	5.7
Boyolangu	5.8

Source : Kabupaten Tulungagung Agricultural Extension Service

Table 13.7 GENERAL CHARACTERISTICS OF CORN VARIETIES

Variety	Year Released	Maturity (day)	Average Yield (ton/ha)	Reaction to	
				Downy Mildew	Rust
Arjuna	1980	90	4.0	T	AT
Hibrida C_1	1980	100	5.8	AT	-

Source : High-Yielding Varieties of Food Crops released in Indonesia, Bogor, 1984

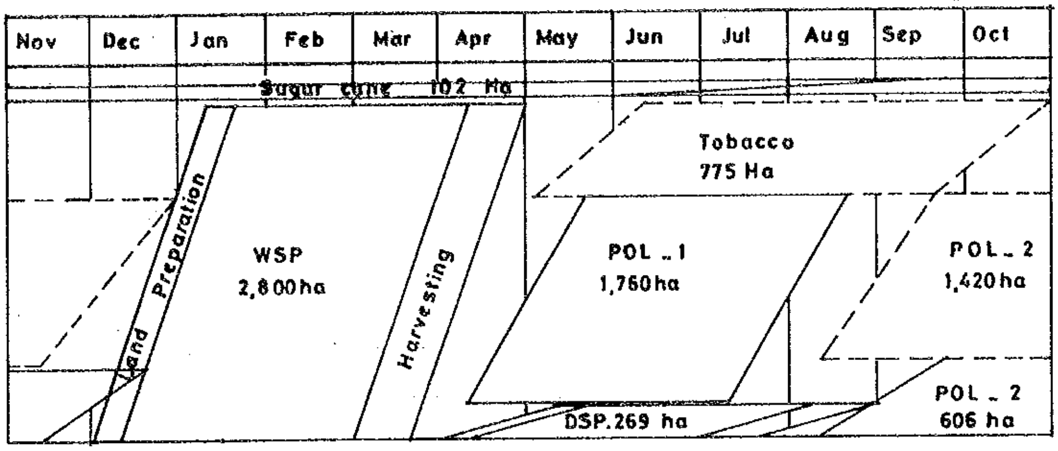
Note : T : resistant
AT : Moderately resistant

Table 13.8 CROP PRODUCTION UNDER WITH AND WITHOUT PROJECT CONDITION

	With Project			Without Project			Incremental Production
	Area (ha)	Unit Yield (ton/ha)	Production (ton)	Area	Unit Yield (ton/ha)	Production (ton)	(ton)
Paddy			16,880			11,634	
- Wet season	2,800	5.50	15,400	2,707	3.91	10,584	5,246
- Dry season	269	5.50	1,480	269	3.91	1,050	
Maize			5,103			1,697	3,406
- Irrigated	880	4.00	3,520	-	-	-	
- Non-irrigated	710	2.23	1,583	761	2.23	1,697	
Soybean			1,715			482	
- Irrigated	880	1.40	1,232	-	-	-	1,233
- Non-irrigated	710	0.68	483	709	0.68	482	-
Red Onion	606	8.0	4,848	-	-	-	4,848
Sugarcane	102	90.00	9,180	102	56.9	5,804	3,376
Tobacco	775	2.89	2,240	775	2.89	2,240	0

Table 13.9 FARM ECONOMY IN WIDAS EXTENSION AREA WITH PROJECT AT THE AVERAGE FARM SIZE OF 0.45 HA (the year of 2000)

No.	Items	Area (Ha)	Unit Yield (ton/ha)	Unit Price (Rp/kg)	Amount (Rp)
I.	Gross income				2,595,545
	1. Farm income				2,316,045
	Wet season paddy	0.95	5.5	163.66	855,124
	Dry season paddy	0.09	5.5	163.66	81,012
	Maize	0.53	4.0	109.16	231,419
	Soybean	0.53	1.4	480	356,160
	Sugarcane	0.03	9.0	539	145,530
	Red Onion	0.21	8.0	385	646,800
	Live stock	-	-	-	189,500
	2. Off farm income				90,000
II.	Expenditures				1,771,850
	1. Production cost				861,767
	Wet season paddy	0.95			344,119
	Dry season paddy	0.09			32,600
	Maize	0.53			132,102
	Soybean	0.53			75,589
	Sugarcane	0.03			25,446
	Red Onion	0.21			251,911
	2. Living expenses				910,080
III.	Net income				823,500



WSP : Wet season paddy
DSP : Dray Season paddy
POL-1 : Polowijo Crops - 1
POL-2 : Polowijo Crops - 2

Fig. 13.1 PROPOSED CROPPING PATTERN

CHAPTER 14 HYDROLOGY

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14. HYDROLOGY

14.1 Lowflow Analysis

14.1.1 General

For planning the water resources development, long-term reliable runoff data are of vital necessity. However, the water level observation at the Kedungwarak site has started since 1979, and there is no record at the Ketandan site. Therefore, it is necessary to estimate the runoff from the rainfall. For estimation of runoff from rainfall, the non-humid type Tank Model developed by Dr. Sugawara is used. Details of Tank Model are presented in ANNEX-2.

The sites where the lowflow analysis is made are the Kedungwarak site (C.A = 31.5 km^2) and the Ketandan site (C.A = 15.5 km^2). Locations and watershed areas of them are shown on Fig.14.1.

14.1.2 Input data to tank model

1. Rainfall

In the upstream of the Kedungwarak site, Tempuran rain gauging station exists. Near the Ketandan site, Bangle station exists. Reliabilities of the rainfall records of these stations are checked with the rainfall records at Matokan and Tretes by the double mass curve method as shown on Fig.14.2. The corelation among Bangle, Matokan and Tretes is well, but that between Tempuran and other stations shows something wrong in the Tempuran data in 1960's. Taking the above, into account the rainfall data at Tempuran from 1960 to 1967 are replaced with those at Bangle. The input data are shown on the 10-day basis in ANNEX-2.

2. Evaportranspiration

As for the evapotranspiration, the values estimated from the meteorological data by the modified Penmann Method are taken. The meteorological data is presented in ANNEX-2.

The values are as follows;

Unit : mm/day

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
4.5	4.7	4.6	4.6	4.2	4.1	4.5	4.9	5.8	5.7	5.2	4.7

3. Discharge Data

At the Kedungwarak site, the hourly water records and discharge measurement records are available. However, lower water level than 50 cm could not be measured, owing to change in the river course.

Therefore, although its accuracy is questionable, the intake discharge records in the Senggowar irrigation system are used for checking the simulation result by the Tank Model. The intake discharge used is shown in ANNEX-2.

4. Runoff Coefficient

For adjustment of the runoff coefficient, the runoff coefficient at the Ngudikan weir on the main Widas river studied in PART-I study is examined. The long-term runoff coefficient at the weir is 52% as shown in Table 14.1.

14.1.3 Calibration of tank coefficients

The tank coefficients consisting of hole heights and hole coefficients are calibrated through trial and error. The best set of the tank coefficients is shown in Table 14.2. Fig.14.3 shows comparison of the simulated runoff with the intake discharge at Senggowar. The long-term runoff coefficient is estimated at 0.48.

14.1.4 Simulated runoffs

By inputting the modified rainfall at Tempuran in the period from 1951 to 1983, the runoff at the Kedungwarak site is simulated on the daily basis. The summarized monthly runoffs are shown in Table 14.3.

The runoff at the Ketandan site is estimated by multiplying the catchment area ratio (15.5 km^2./31.5 km^2) to the simulated Kedungwarak runoff. Table 14.4 shows the Ketandan monthly runoff.

14.2 Flood Flow Analysis at Damsite and Headworks

For the feasibility design of the spillway and diversion system, flood flow having small probability is needed. Taking account of the scale of the catchment areas of the Kedungwarak and Ketandan basin and the data availability, the dimensionless unit hydrograph method is employed for estimation of probable flood at the weir and dam sites. Details of the dimensionless unit hydrograph are shown in ANNEX-2.

14.2.1 Rainfall analysis

1. Probable Rainfall

From the scale of the catchment area, one day flood duration is considered flood. Then, the annual maximum daily rainfall at Tempuran and Bangle is sampled as shown in Table 14.5. From the series of the annual maximum daily rainfalls, the probable daily rainfalls are estimated by the Gumbel's method as shown in Table 14.6

2. Hourly Distribution

The hourly rainfall distribution pattern is examined using the data at Ngluyu from 1981 to 1984. The distribution of rainfall more than 60 mm is shown in Table 14.7.

Since the catchment areas are small, the unit time of calculation of floods is set at a half hour. The percentages of half-hour rainfall are distributed as shown in Table 14.7.

14.2.2 Flood flow analysis

At the Kedungwarak site, river water level and discharge measurements were carried out by BRBDEO only when the runoff was low, and it is difficult to prepare a rating curve covering the high water stage from these data. Then, the cross section of the gauge site was surveyed, (see Fig.14.4) and uniform flow calculation is made by the Manning's formula using this cross section. The hydraulic gradient is determined from the average riverbed slope at the gauge site. The hydraulic roughness coefficient is calculated as shown in Table 14.8 from the discharge measurement records and the cross section.

Using rating curve constructed by the Manning's formula, the water levels showing flood are converted into the discharges. The converted discharges are shown in ANNEX-2.

14.2.3 Flood runoff coefficient

From the converted flood discharges and the daily rainfall at the flood time, the flood runoff coefficients are estimated as shown in Fig. 14.5. The distribution of the coefficients seems to coicide with the Curve No.77 of the US Soil Conservation Service 288-D-2549.

Therefore the Curve No.77 is used.

14.2.4 Dimensionless unit hydrograph

From the converted flood discharges, the dimensioness unit hydrographis drawn as shown on Fig.14.6. The typical dimensionless unit hydrograph is determined as shown on Fig.14.7.

14.2.5 Probable floods

Using the estimated probable rainfalls, half-hour rainfall distribution patterns, flood runoff coefficient, and dimensionless unit hydrograph, the probable floods are estimated as shown in Table 14.9. The peak flood discharges are as follows;

Unit : m^3/sec

Return Period	Kedungwarak site	Ketandan site	Bangle Headworks Site
20	167	141	148
100	232	196	207
200	260	220	232
10,000	327	358	377

Table 14.1 RUNOFF COEFFICIENT AT NGUDIKAN WEIR

Year	Rainfall 10^6 m^3	Observed Runoff $10^6 m^3$	Observed Runoff Coefficient	Computed Runoff $10^6 m^3$	Computed Runoff Coefficient
55/56	306.8			96.1	(31%)
56/57	330.3			174.2	(53%)
57/58	421.5			236.4	(56%)
58/59	411.1			207.9	(51%)
59/60	344.1			167.9	(49%)
60/61	261.0	92.8	(30%)	113.3	(43%)
61/62	307.8	127.8	(42%)	141.2	(47%)
62/63	364.4	211.0	(58%)	196.2	(54%)
63/64	359.1			172.7	(48%)
64/65	290.9	167.8	(58%)	145.6	(50%)
65/66	337.1	160.8	(48%)	160.0	(47%)
66/67	275.4			155.4	(49%)
67/68	580.2			328.7	(57%)
68/69	434.8			262.0	(60%)
69/70	365.9			192.9	(53%)
70/71	355.9			156.8	(44%)
71/72	324.4			181.4	(56%)
72/73	376.3	229.1	(61%)	179.1	(48%)
73/74	425.9	208.7	(49%)	221.2	(52%)
74/75	584.1	194.0	(33%)	360.6	(62%)
	7,455.8			3,851.9	(52%)

Source : Feasibility Report on the Widas Irrigation Project Supporting Volume I, Part I Water Study, 1976, BRBDEO

Table 14.2 CALIBRATED TANK COEFFICIENTS

Tank	Hole No.	Hole Height	Coefficient
Top	Side - 1	5	0.10
	Side - 2	10	0.15
	Side - 3	35	0.25
	Bottom	-	0.20
Second	Side	0	0.075
	Bottom	-	0.025
Third	Side	0	0.010
	Bottom	-	0.001
Forth	Side	0	0.0003
	Bottom	-	0

Table 14.3 ESTIMATED MONTHLY RUNOFF AT K. WARAK SITE

UNIT: M^3/SEC

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1951	0.98	0.90	1.10	0.28	0.17	0.70	0.12	0.07	0.03	0.02	0.02	2.04	0.54
1952	1.91	1.43	3.07	1.73	0.49	0.26	0.31	0.16	0.11	0.07	1.05	2.64	1.10
1953	1.20	1.97	2.89	4.54	1.85	0.61	0.48	0.31	0.23	0.15	0.14	1.10	1.29
1954	3.07	1.60	1.95	1.01	0.59	0.29	0.27	0.18	0.12	0.07	1.51	3.16	1.15
1955	1.57	1.10	1.27	1.67	0.58	0.32	0.71	0.75	0.25	0.18	1.01	0.50	0.83
1956	0.72	0.96	1.63	0.45	0.25	0.51	0.27	0.17	0.11	0.07	0.12	0.67	0.49
1957	1.41	2.14	3.28	1.28	0.48	0.25	0.20	0.25	0.11	0.05	0.10	0.67	0.85
1958	1.26	1.98	1.20	6.14	1.05	0.46	0.28	0.23	0.17	0.11	0.43	0.87	1.18
1959	1.43	1.25	0.91	1.07	0.76	0.42	0.20	0.15	0.10	0.04	0.02	0.69	0.59
1960	1.82	1.26	2.89	1.25	0.81	0.33	0.45	0.18	0.12	0.06	0.22	0.57	0.83
1961	0.73	1.61	1.18	0.91	1.40	0.33	0.16	0.11	0.06	0.02	0.24	0.19	0.58
1962	1.94	1.13	1.49	1.46	1.02	0.36	0.19	0.13	0.08	0.03	0.95	1.11	0.82
1963	1.19	1.29	2.30	1.98	0.78	0.47	0.25	0.19	0.12	0.06	0.09	1.10	0.82
1964	0.99	1.56	1.97	0.78	1.12	0.48	0.22	0.16	0.10	1.02	0.58	0.47	0.79
1965	1.20	2.06	1.06	0.77	0.19	0.23	0.13	0.07	0.02	0.01	0.01	1.45	0.60
1966	1.42	1.90	2.43	1.44	1.09	0.73	0.26	0.20	0.13	0.11	0.13	2.01	0.99
1967	1.64	2.30	2.26	1.97	0.51	0.25	0.20	0.13	0.08	0.02	0.02	2.07	0.95
1968	1.13	1.33	2.37	2.81	1.07	1.07	1.44	0.51	0.30	0.23	0.58	1.64	1.21
1969	0.82	1.60	2.21	0.85	0.35	0.22	0.17	0.11	0.05	0.01	0.06	1.01	0.62
1970	1.34	2.86	2.11	0.92	0.94	0.35	0.23	0.17	0.11	0.06	0.28	1.63	0.92
1971	2.93	2.01	2.21	1.94	1.71	1.23	0.43	0.30	0.23	0.49	2.10	2.42	1.50
1972	1.55	0.86	1.69	0.66	0.98	0.24	0.18	0.11	0.06	0.02	0.11	1.49	0.66
1973	3.90	4.04	2.01	1.31	1.88	0.76	0.38	0.31	0.69	0.39	1.06	1.30	1.50
1974	0.89	1.97	1.20	2.30	1.28	0.40	0.26	0.27	0.24	0.46	0.53	3.05	1.07
1975	1.73	1.10	3.17	2.76	1.58	0.68	0.36	0.29	0.29	0.79	0.95	2.29	1.33
1976	0.96	0.41	0.89	0.59	0.22	0.16	0.10	0.05	0.01	0.01	0.53	0.68	0.38
1977	1.32	1.83	1.34	1.44	0.33	0.93	0.23	0.14	0.08	0.03	0.03	1.38	0.76
1978	2.06	1.98	1.09	0.53	0.34	0.82	0.76	0.24	0.16	0.10	0.06	1.12	0.77
1979	2.29	1.55	0.98	0.70	0.94	0.58	0.21	0.15	0.09	0.04	0.04	0.82	0.70
1980	1.36	1.17	0.61	0.57	0.35	0.15	0.13	0.17	0.04	0.01	0.70	3.09	0.70
1981	1.67	0.95	1.14	0.57	1.26	0.30	0.27	0.15	0.45	0.25	0.72	1.39	0.76
1982	1.86	2.99	5.52	1.74	0.65	0.32	0.31	0.20	0.13	0.07	0.02	2.17	1.33
1983	1.84	1.74	1.67	1.08	1.21	0.54	0.25	0.19	0.13	0.29	0.84	0.78	0.88
mean	1.58	1.66	1.91	1.50	0.86	0.48	0.32	0.21	0.15	0.16	0.46	1.44	0.89

Table 14.4 ESTIMATED MONTHLY RUNOFF AT KETANDAN SITE

UNIT: M^3/SEC

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1951	0.48	0.44	0.54	0.13	0.08	0.34	0.06	0.03	0.01	0.01	0.01	1.00	0.26
1952	0.94	0.70	1.51	0.85	0.24	0.13	0.15	0.08	0.05	0.03	0.51	1.30	0.54
1953	0.59	0.97	1.42	2.23	0.91	0.30	0.23	0.15	0.11	0.07	0.07	0.54	0.63
1954	1.51	0.78	0.96	0.49	0.29	0.14	0.13	0.08	0.06	0.03	0.74	1.55	0.56
1955	0.77	0.54	0.62	0.82	0.28	0.15	0.35	0.37	0.12	0.09	0.50	0.24	0.40
1956	0.35	0.47	0.80	0.22	0.12	0.25	0.13	0.08	0.05	0.03	0.06	0.33	0.24
1957	0.69	1.05	1.61	0.63	0.23	0.12	0.10	0.12	0.05	0.02	0.05	0.33	0.42
1958	0.62	0.97	0.59	3.02	0.52	0.22	0.14	0.11	0.08	0.05	0.21	0.42	0.58
1959	0.70	0.61	0.44	0.52	0.37	0.21	0.10	0.07	0.04	0.02	0.01	0.34	0.29
1960	0.90	0.62	1.42	0.61	0.39	0.16	0.22	0.09	0.06	0.03	0.11	0.28	0.41
1961	0.35	0.79	0.58	0.44	0.68	0.16	0.08	0.05	0.03	0.01	0.11	0.09	0.28
1962	0.95	0.55	0.73	0.72	0.50	0.17	0.09	0.06	0.04	0.01	0.47	0.55	0.40
1963	0.58	0.63	1.13	0.97	0.38	0.23	0.12	0.09	0.06	0.03	0.04	0.54	0.40
1964	0.48	0.77	0.97	0.38	0.55	0.23	0.11	0.08	0.05	0.50	0.28	0.23	0.38
1965	0.59	1.01	0.52	0.38	0.09	0.11	0.06	0.03	0.01	0.00	0.00	0.71	0.29
1966	0.69	0.93	1.19	0.71	0.53	0.35	0.13	0.10	0.06	0.05	0.06	0.99	0.48
1967	0.80	1.13	1.11	0.96	0.25	0.12	0.09	0.06	0.03	0.01	0.01	1.02	0.47
1968	0.55	0.65	1.17	1.38	0.52	0.53	0.71	0.25	0.15	0.11	0.28	0.80	0.59
1969	0.40	0.79	1.09	0.41	0.17	0.11	0.08	0.05	0.02	0.00	0.03	0.50	0.30
1970	0.65	1.41	1.04	0.45	0.46	0.17	0.11	0.08	0.05	0.03	0.13	0.80	0.45
1971	1.44	0.99	1.09	0.95	0.84	0.60	0.21	0.15	0.11	0.24	1.03	1.19	0.74
1972	0.76	0.42	0.83	0.32	0.48	0.12	0.08	0.05	0.03	0.00	0.05	0.73	0.32
1973	1.92	1.98	0.99	0.64	0.92	0.37	0.19	0.15	0.34	0.19	0.52	0.64	0.74
1974	0.44	0.97	0.59	1.13	0.63	0.19	0.13	0.13	0.12	0.22	0.26	1.50	0.52
1975	0.85	0.54	1.56	1.35	0.78	0.33	0.17	0.14	0.14	0.39	0.47	1.12	0.65
1976	0.47	0.20	0.44	0.29	0.11	0.07	0.05	0.02	0.00	0.00	0.26	0.33	0.19
1977	0.65	0.90	0.66	0.70	0.16	0.45	0.11	0.07	0.04	0.01	0.01	0.67	0.37
1978	1.01	0.97	0.53	0.26	0.17	0.40	0.37	0.12	0.07	0.05	0.03	0.55	0.38
1979	1.13	0.76	0.48	0.34	0.46	0.28	0.10	0.07	0.04	0.02	0.02	0.40	0.34
1980	0.67	0.57	0.30	0.28	0.17	0.07	0.06	0.08	0.02	0.00	0.34	1.52	0.34
1981	0.82	0.46	0.56	0.28	0.62	0.15	0.13	0.07	0.22	0.12	0.35	0.68	0.37
1982	0.91	1.47	2.72	0.86	0.32	0.16	0.15	0.10	0.06	0.03	0.01	1.07	0.65
1983	0.90	0.86	0.82	0.53	0.60	0.26	0.12	0.09	0.06	0.14	0.41	0.38	0.43
mean	0.77	0.82	0.94	0.74	0.42	0.23	0.15	0.10	0.07	0.08	0.22	0.71	0.44

Table 14.5 ANNUAL MAXIMUM DAILY RAINFALL

(Unit : mm)

No.	Year	Tempuran	Bangle
1.	50/51	180	174
2.	51/52	105	110
3.	52/53	150	93
4.	53/54	80	76
5.	54/55	122	88
6.	55/56	76	99
7.	56/57	117	94
8.	57/58	84	110
9.	58/59	56	110
10.	59/60	47	120
11.	60/61	76	79
12.	61/62	96	86
13.	62/63	147	80
14.	63/64	135	112
15.	64/65	46	90
16.	65/66	123	110
17.	66/67	67	100
18.	67/68	67	110
19.	68/69	71	82
20.	69/70	78	67
21.	70/71	85	115
22.	71/72	121	65
23.	72/73	87	64
24.	73/74	70	112
25.	74/75	94	85
26.	75/76	87	87
27.	76/77	88	115
28.	77/78	89	91
29.	78/79	140	95
30.	79/80	65	99
31.	80/81	94	76
32.	81/82	108	97
33.	82/83	96	97

Table 14.6 PROBABLE DAILY RAINFALL

(Gumbel Method)

(Unit : mm)

T	Tempuran		Bangle	
	Yt	Xt	Yt	Xt
2	0.3665	90.65	0.3665	93.48
3	0.9027	105.31	0.9027	103.21
4	1.2459	114.7	1.2459	109.44
5	1.4999	121.64	1.4999	114.06
6	1.702	127.17	1.702	117.72
7	1.8698	131.76	1.8698	120.77
8	2.0134	135.68	2.0134	123.38
9	2.1389	139.11	2.1389	125.66
10	2.2504	142.16	2.2504	127.68
11	2.3506	144.9	2.3506	129.5
12	2.4417	147.39	2.4417	131.15
13	2.5252	149.68	2.5252	132.67
14	2.6022	151.78	2.6022	134.07
15	2.6738	153.74	2.6738	135.37
16	2.7405	155.56	2.7405	136.58
17	2.8031	157.27	2.8031	137.71
18	2.8619	158.88	2.8619	138.78
19	2.9175	160.4	2.9175	139.79
20	2.9702	161.84	2.9702	140.75
30	3.3843	173.17	3.3843	148.27
40	3.6762	181.15	3.6762	153.57
50	3.9019	187.32	3.9019	157.67
60	4.086	192.35	4.086	161.01
70	4.2413	196.6	4.2413	163.83
80	4.3757	200.28	4.3757	166.27
100	4.6001	206.41	4.6001	170.34
200	5.2958	225.43	5.2958	182.97
300	5.7021	236.54	5.7021	190.35
400	5.9902	244.42	5.9902	195.58
500	6.2136	250.53	6.2136	199.64
600	6.3961	255.52	6.3961	202.95
700	6.5504	259.73	6.5504	205.75
800	6.684	263.39	6.684	208.18
900	6.8018	266.61	6.8018	210.32
1000	6.9073	269.49	6.9073	212.23
2000	7.6007	288.45	7.6007	224.82
3000	8.0062	299.54	8.0062	232.18
4000	8.2939	307.41	8.2939	237.41
5000	8.5171	313.51	8.5171	241.46
10000	9.2103	332.46	9.2103	254.04

Table 14.7 HOURLY DISTRIBUTION RAINFALL AT NGLUYU

(Unit : mm)

Date	Hour 1	2	3	4	5	Total
June 27, '81	47.0	54.5	1.5	-	-	103.0
March 9, '83	11.0	66.0	5.8	-	-	82.8
May 26, '83	3.9	50.0	8.8	0.1	-	62.8
Jan. 30, '84	30.5	52.0	2.0	1.0	0.9	86.4
Feb. 6 , '84	24.8	53.0	5.5	1.0	-	84.3
Apr. 12, '84	30.5	35.0	3.0	-	-	68.5
Total (mm)	147.7	310.5	26.6	2.1	0.9	487.8
Mean (mm)	24.6	51.8	4.4	0.4	0.2	-
Distribution (%)	30.3	63.7	5.4	0.4	0.2	100

Half Hour	1/2	1	1-1/2	2	21/2	3	31/2	4	41/2	5
Distribution (%)	12.6	17.7	24.0	39.7	2.8	2.6	0.3	0.1	0.1	0.1

Table 14.8 ESTIMATED ROUGHNESS COEFFICIENT OF THE KEDUNGWARAK RIVER AT DAM SITE

No.	Date		Q (m^3/sec)	H=R (m)	$R^{2/3}$	$I^{1/2}$	A (m^2)	V (m/sec)	n
3	5/4/'83	0.98	3.039	0.420	0.561	0.0830	5.88	0.517	0.090
5	5/5/'83	1.00	1.954	0.336	0.483	0.0830	4.37	0.447	0.090
6	21/11/'83	0.99	1.180	0.290	0.438	0.0830	3.19	0.370	0.098
7	23/1/'84	0.97	1.177	0.258	0.405	0.0830	3.09	0.381	0.088
8	29/1/'84	1.00	1.545	0.312	0.460	0.0830	4.05	0.381	0.100
9	30/1/'84	1.00	1.572	0.314	0.462	0.0830	4.09	0.384	0.100
10	13/2/'84	1.19	2.865	0.384	0.528	0.0830	6.14	0.466	0.094
11	26/3/'84	0.98	1.051	0.235	0.381	0.0830	4.23	0.248	0.128
12	12/2/'85	1.18	3.253	0.409	0.551	0.0830	6.13	0.531	0.086
					Average				0.097

≒ 0.100

Q : Observed discharge
R : Hydraulic radius
I : River gradient estimated from 1 to 2,500 scale map
A : Flow area
V : Mean velocity
n : Roughness coefficient

Table 14.9 ESTIMATE OF FLOOD DISCHARGE AT KEDUNGWARAK DAM SITE, KETANDAN DAM SITE AND BANGLE WEIR SITE (1/2)

(1) Unit Hydrograph

FLOOD DISCHARGE AT K.WAHAK
CATCHMENT AREA 31.5 SQ.KM
LAG TIME 3 HOURS

TIME	θ-TIME	UNIT Q
.5	16.67	.01
1	33.33	.76
1.5	50	1.82
2	66.67	1.66
2.5	83.33	1.47
3	100	1.28
3.5	116.67	1.06
4	133.33	.91
4.5	150	.79
5	166.67	.7
5.5	183.33	.62
6	200	.55
6.5	216.67	.49
7	233.33	.44
7.5	250	.39
8	266.67	.34
8.5	283.33	.3
9	300	.27
9.5	316.67	.24
10	333.33	.21
10.5	350	.19
11	366.67	.16
11.5	383.33	.14
12	400	.13
12.5	416.67	.19
13	433.33	.17
13.5	450	.09
14	466.67	.08
14.5	483.33	.07
15	500	.05
15.5	516.67	.05
16	533.33	.05
16.5	550	.04
17	566.67	.04
17.5	583.33	.03
18	600	.03
18.5	616.67	.03
19	633.33	.02
19.5	650	.02
20	666.67	.02
20.5	683.33	.02
21	700	.01

FLOOD DISCHARGE AT KETANDAN
CATCHMENT AREA 15.5 SQ:KM
LAG TIME 1.2 HOURS

TIME	θ-TIME	UNIT Q
.5	41.67	1.44
1	83.33	1.81
1.5	125	1.2
2	166.67	.86
2.5	208.33	.64
3	250	.48
3.5	291.67	.35
4	333.33	.26
4.5	375	.19
5	416.67	.23
5.5	458.33	.1
6	500	.07
6.5	541.67	.06
7	583.33	.04
7.5	625	.03
8	666.67	.02

FLOOD DISCHARGE AT BANGLE
CATCHMENT AREA 22 SQ.KM
LAG TIME 2.1 HOURS

TIME	θ-TIME	UNIT Q
.5	23.81	.29
1	47.62	1.6
1.5	71.43	1.61
2	95.24	1.33
2.5	119.05	1.03
3	142.86	.84
3.5	166.67	.7
4	190.48	.58
4.5	214.29	.5
5	238.1	.42
5.5	261.9	.35
6	285.71	.29
6.5	309.52	.25
7	333.33	.21
7.5	357.14	.18
8	380.95	.15
8.5	404.76	.14
9	428.57	.2
9.5	452.38	.09
10	476.19	.07
10.5	500	.06
11	523.81	.05
11.5	547.62	.04
12	571.43	.04
12.5	595.24	.03
13	619.05	.03
13.5	642.86	.02
14	666.67	.02
14.5	690.48	.01

(2) Kedungwarak Damsite

	10-YEAR		20-YEAR		100-YEAR		200-YEAR		1,000-YEAR		10,000-YEAR	
TIME	RAIN	Q	RAIN	Q	RAIN	Q	RAIN	Q	RAIN	Q	RAIN	Q
.5	10.99	2.68	13.24	2.71	18.5	2.78	20.77	2.82	26.11	2.89	33.82	3
1	15.44	11.04	18.6	12.78	25.98	16.86	29.18	18.62	36.68	22.76	47.51	28.74
1.5	20.93	34.51	25.22	41.07	35.23	56.36	39.56	62.98	49.73	78.52	64.42	100.97
2	34.62	65.17	41.72	78.01	58.28	107.97	65.45	120.94	82.26	151.37	106.57	195.35
2.5	2.49	108.61	2.94	130.36	4.11	181.08	4.62	203.04	5.8	254.57	7.52	329.04
3	2.27	138.93	2.73	166.9	3.82	232.12	4.29	260.36	5.39	326.62	6.98	422.38
3.5	.26	128.25	.32	154.03	.44	214.14	.49	240.18	.62	301.24	.81	389.51
4	.09	114.95	.11	138	.15	191.76	.16	215.04	.21	269.64	.27	348.57
4.5	.09	99.56	.11	119.46	.15	165.85	.16	185.95	.21	233.08	.27	301.2
5	.09	85.34	.11	102.32	.15	141.92	.16	159.07	.21	199.29	.27	257.44
5.5	0	74.28	0	88.99	0	123.29	0	138.15	0	173	0	223.37
6	0	65.42	0	78.31	0	108.39	0	121.41	0	151.96	0	196.12
6.5	0	58.08	0	69.47	0	96.03	0	107.53	0	134.51	0	173.52
7	0	51.75	0	61.84	0	85.38	0	95.57	0	119.48	0	154.04
7.5	0	46.27	0	55.24	0	76.15	0	85.21	0	106.46	0	137.17
8	0	41.45	0	49.43	0	68.04	0	76.1	0	95.01	0	122.34
8.5	0	37.07	0	44.16	0	60.68	0	67.83	0	84.62	0	108.87
9	0	33.12	0	39.4	0	54.03	0	60.37	0	75.23	0	96.71
9.5	0	29.46	0	34.99	0	47.87	0	53.45	0	66.53	0	85.45
10	0	26.41	0	31.3	0	42.72	0	47.67	0	59.27	0	76.04
10.5	0	23.76	0	28.12	0	38.27	0	42.67	0	52.99	0	67.9
11	0	21.34	0	25.2	0	34.19	0	38.09	0	47.23	0	60.44
11.5	0	19.16	0	22.58	0	30.53	0	33.98	0	42.06	0	53.75
12	0	17.22	0	20.23	0	27.25	0	30.3	0	37.43	0	47.75
12.5	0	16.3	0	19.13	0	25.72	0	28.57	0	35.26	0	44.94
13	0	15.85	0	18.59	0	24.96	0	27.72	0	34.2	0	43.56
13.5	0	15.23	0	17.84	0	23.92	0	26.55	0	32.72	0	41.65
14	0	15.45	0	18.1	0	24.28	0	26.95	0	33.23	0	42.3
14.5	0	12.88	0	15.01	0	19.96	0	22.11	0	27.14	0	34.41
15	0	9.81	0	11.3	0	14.78	0	16.29	0	19.83	0	24.95
15.5	0	8.85	0	10.15	0	13.17	0	14.48	0	17.56	0	22
16	0	8	0	9.13	0	11.75	0	12.88	0	15.54	0	19.39
16.5	0	7.37	0	8.37	0	10.69	0	11.69	0	14.05	0	17.46
17	0	6.83	0	7.71	0	9.77	0	10.67	0	12.76	0	15.79
17.5	0	6.33	0	7.11	0	8.94	0	9.73	0	11.58	0	14.26
18	0	5.89	0	6.58	0	8.18	0	8.88	0	10.52	0	12.88
18.5	0	5.49	0	6.1	0	7.52	0	8.14	0	9.58	0	11.66
19	0	5.14	0	5.68	0	6.93	0	7.48	0	8.75	0	10.59
19.5	0	4.83	0	5.31	0	6.41	0	6.89	0	8.01	0	9.64
20	0	4.56	0	4.98	0	5.95	0	6.38	0	7.37	0	8.8
20.5	0	4.32	0	4.68	0	5.54	0	5.91	0	6.79	0	8.05
21	0	4.1	0	4.42	0	5.17	0	5.5	0	6.27	0	7.37
21.5	0	3.78	0	4.03	0	4.63	0	4.89	0	5.5	0	6.39
22	0	3.44	0	3.63	0	4.07	0	4.26	0	4.7	0	5.35
22.5	0	3.08	0	3.19	0	3.46	0	3.57	0	3.84	0	4.23
23	0	2.6	0	2.61	0	2.65	0	2.67	0	2.71	0	2.76
23.5	0	2.56	0	2.57	0	2.59	0	2.6	0	2.61	0	2.64
24	0	2.53	0	2.53	0	2.53	0	2.54	0	2.54	0	2.55
24.5	0	2.52	0	2.52	0	2.53	0	2.53	0	2.53	0	2.53
25	0	2.52	0	2.52	0	2.52	0	2.52	0	2.53	0	2.53
25.5	0	2.52	0	2.52	0	2.52	0	2.52	0	2.52	0	2.52

FLOOD RUNOFF COEFFICIENT

1	.557799152
2	.590727996
3	.646818504
4	.665159598
5	.699259199
6	.734231294

Table 14. 9 ESTIMATE OF FLOOD DISCHARGE AT KEDUNGWARAK DAM SITE, KETANDAN DAM SITE AND BANGLE SITE (2/2)

(3) Ketandan Dam Site

TIME	10-YEAR RAIN	10-YEAR Q	20-YEAR RAIN	20-YEAR Q	100-YEAR RAIN	100-YEAR Q	200-YEAR RAIN	200-YEAR Q	1,000-YEAR RAIN	1,000-YEAR Q	10,000-YEAR RAIN	10,000-YEAR Q
.5	10.99	17.1	13.24	20.35	18.5	27.94	20.77	31.22	26.11	38.92	33.82	50.06
1	15.44	43.41	18.6	52.06	25.98	72.22	29.18	80.95	36.68	101.43	47.51	131.04
1.5	20.93	72.53	25.22	87.15	35.23	121.24	39.56	136	49.73	170.63	64.42	220.67
2	34.62	117	41.72	140.73	58.28	196.08	65.45	220.05	82.26	276.27	106.57	357.53
2.5	2.44	112.71	2.94	135.56	4.11	188.86	4.62	211.94	5.8	266.08	7.52	344.33
3	2.27	83.39	2.73	100.23	3.82	139.51	4.29	156.52	5.39	196.42	6.98	254.09
3.5	.26	62.89	.32	75.53	.44	105.01	.49	117.77	.62	147.72	.81	191
4	.09	46.89	.11	56.25	.15	78.07	.16	87.52	.21	109.7	.27	141.74
4.5	.09	35.24	.11	42.21	.15	58.47	.16	65.51	.21	82.02	.27	105.89
5	.09	27.37	.11	32.72	.15	45.22	.16	50.63	.21	63.32	.27	81.66
5.5	0	21.26	0	25.37	0	34.94	0	39.09	0	48.81	0	62.87
6	0	16.77	0	19.96	0	27.38	0	30.6	0	38.14	0	49.04
6.5	0	14.45	0	17.16	0	23.47	0	26.21	0	32.62	0	41.89
7	0	8.8	0	10.36	0	13.97	0	15.54	0	19.21	0	24.52
7.5	0	6.86	0	8.02	0	10.71	0	11.87	0	14.6	0	18.55
8	0	5.26	0	6.08	0	8	0	8.84	0	10.79	0	13.61
8.5	0	4	0	4.57	0	5.89	0	6.46	0	7.8	0	9.74
9	0	3.02	0	3.38	0	4.23	0	4.6	0	5.47	0	6.71
9.5	0	2.2	0	2.4	0	2.86	0	3.06	0	3.53	0	4.21
10	0	1.39	0	1.42	0	1.49	0	1.53	0	1.6	0	1.71
10.5	0	1.31	0	1.33	0	1.36	0	1.38	0	1.41	0	1.46
11	0	1.26	0	1.26	0	1.27	0	1.27	0	1.28	0	1.29
11.5	0	1.25	0	1.25	0	1.25	0	1.26	0	1.26	0	1.36
12	0	1.24	0	1.25	0	1.25	0	1.25	0	1.25	0	1.25
12.5	0	1.24	0	1.24	0	1.24	0	1.24	0	1.24	0	1.25

FLOOD RUNOFF COEFFICIENT

1	.553587997
2	.586268243
3	.64193529
4	.660137916
5	.693980079
6	.728688149

(4) Bangle Weir Site

TIME	10-YEAR RAIN	10-YEAR Q	20-YEAR RAIN	20-YEAR Q	100-YEAR RAIN	100-YEAR Q	200-YEAR RAIN	200-YEAR Q	1,000-YEAR RAIN	1,000-YEAR Q	10,000-YEAR RAIN	10,000-YEAR Q
.5	10.99	4.98	13.24	5.64	18.5	7.18	20.77	7.84	26.11	9.41	33.82	11.66
1	15.44	23.9	18.6	28.44	25.98	39.03	29.18	43.61	36.68	54.37	47.51	69.91
1.5	20.93	50.32	25.22	60.28	35.23	83.5	39.56	93.55	49.73	117.14	64.42	151.23
2	34.62	84.87	41.72	101.91	58.28	141.65	65.45	158.86	82.26	199.22	106.57	257.57
2.5	2.44	123.52	2.94	148.48	4.11	206.69	4.62	231.9	5.8	291.04	7.52	376.51
3	2.27	114.97	2.73	138.17	3.82	192.3	4.29	215.74	5.39	270.72	6.98	350.19
3.5	.26	97.54	.32	117.17	.44	162.97	.49	182.8	.62	229.32	.81	296.55
4	.09	79.61	.11	95.57	.15	132.79	.16	148.91	.21	186.72	.27	241.36
4.5	.09	65.89	.11	79.03	.15	109.7	.16	122.97	.21	154.12	.27	199.14
5	.09	55.43	.11	66.44	.15	92.1	.16	103.21	.21	129.28	.27	166.96
5.5	0	47.01	0	56.28	0	77.92	0	87.28	0	109.26	0	141.02
6	0	39.95	0	47.78	0	66.04	0	73.95	0	92.49	0	119.3
6.5	0	33.96	0	40.56	0	55.96	0	62.63	0	78.27	0	100.88
7	0	28.75	0	34.29	0	47.19	0	52.78	0	65.09	0	84.84
7.5	0	24.43	0	29.08	0	39.92	0	44.61	0	55.63	0	71.54
8	0	20.88	0	24.79	0	33.93	0	37.89	0	47.18	0	60.59
8.5	0	18.02	0	21.35	0	29.12	0	32.49	0	40.38	0	51.79
9	0	16.54	0	19.57	0	26.64	0	29.7	0	36.88	0	47.26
9.5	0	14.88	0	17.56	0	23.84	0	26.55	0	32.92	0	42.13
10	0	13.85	0	16.33	0	22.11	0	24.61	0	30.49	0	38.97
10.5	0	13.01	0	15.31	0	20.69	0	23.02	0	28.48	0	36.38
11	0	8.64	0	10.05	0	13.34	0	14.77	0	18.11	0	22.94
11.5	0	7.54	0	8.72	0	11.48	0	12.68	0	15.49	0	19.54
12	0	6.46	0	7.42	0	9.67	0	10.65	0	12.93	0	16.23
12.5	0	5.71	0	6.52	0	8.4	0	9.22	0	11.14	0	13.91
13	0	5.07	0	5.75	0	7.34	0	8.02	0	9.63	0	11.96
13.5	0	4.53	0	5.1	0	6.43	0	7	0	8.35	0	10.3
14	0	4.07	0	4.54	0	5.65	0	6.13	0	7.25	0	8.87
14.5	0	3.69	0	4.09	0	5.01	0	5.41	0	6.35	0	7.7
15	0	3.23	0	3.54	0	4.24	0	4.55	0	5.26	0	6.3
15.5	0	2.8	0	3.01	0	3.51	0	3.73	0	4.23	0	4.96
16	0	2.37	0	2.5	0	2.79	0	2.91	0	3.21	0	3.64
16.5	0	1.85	0	1.87	0	1.91	0	1.93	0	1.97	0	2.03
17	0	1.8	0	1.81	0	1.83	0	1.84	0	1.87	0	1.9
17.5	0	1.77	0	1.77	0	1.78	0	1.78	0	1.78	0	1.79
18	0	1.76	0	1.77	0	1.77	0	1.77	0	1.77	0	1.77
18.5	0	1.76	0	1.76	0	1.76	0	1.77	0	1.77	0	1.77
19	0	1.76	0	1.76	0	1.76	0	1.76	0	1.76	0	1.76

FLOOD RUNOFF COEFFICIENT

1	.558259851
2	.591215891
3	.647352726
4	.665708967
5	.699836732
6	.734837711

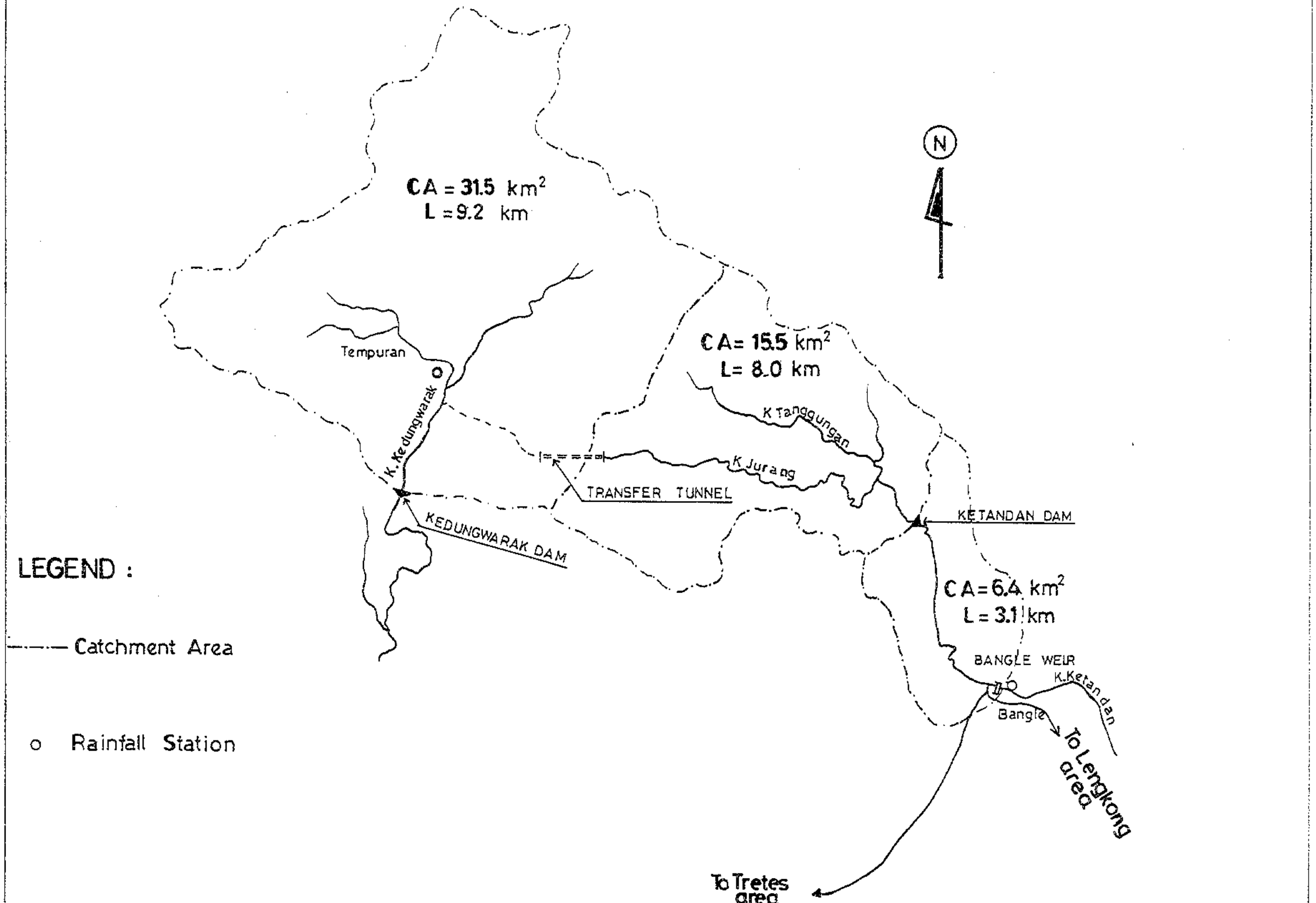

Fig. 14.1 CATCHMENT AREA OF PROPOSED DAM

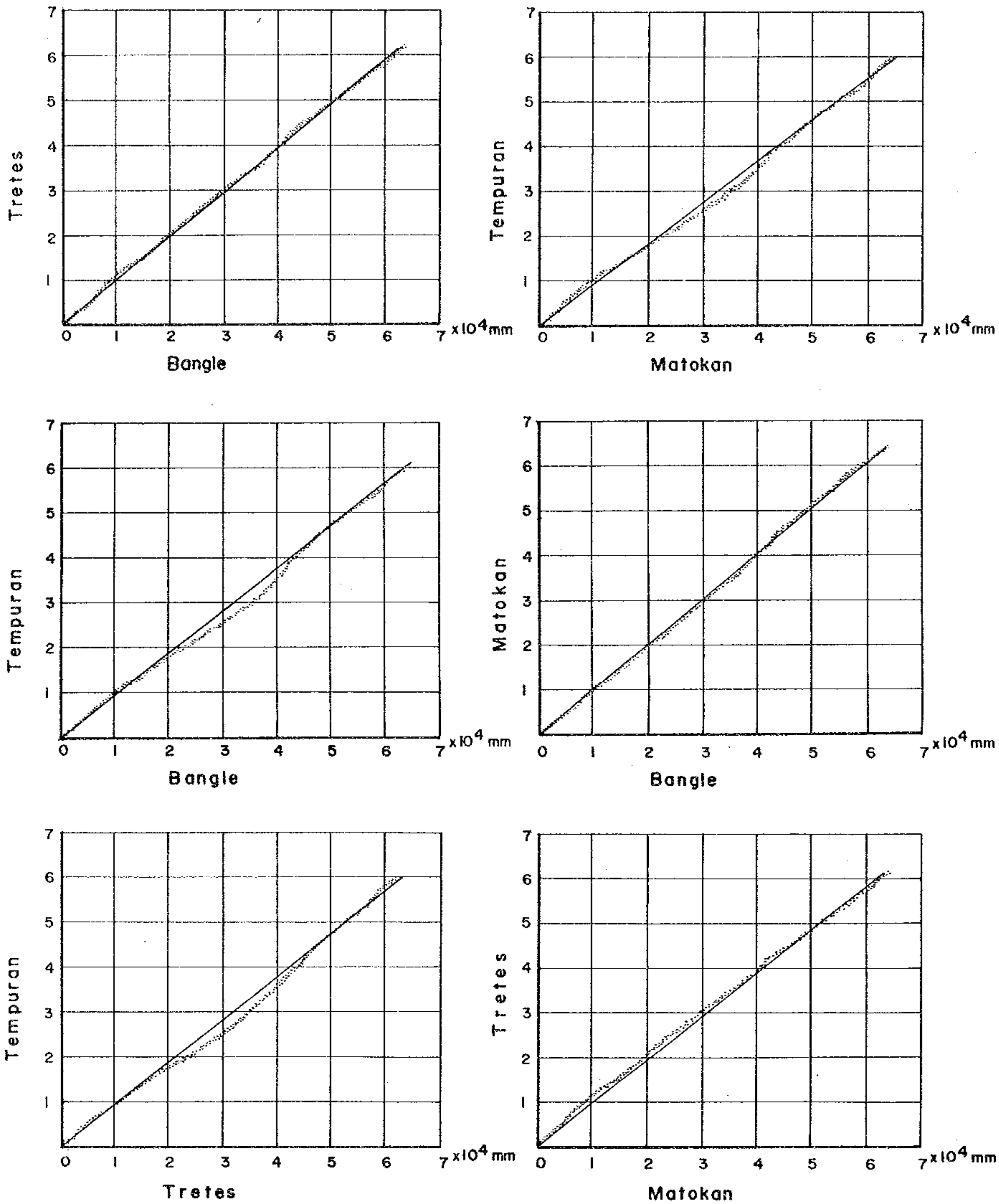

Fig. 14.2 **DOUBLE MASS CURVE ANALYSIS OF RAINFALL**

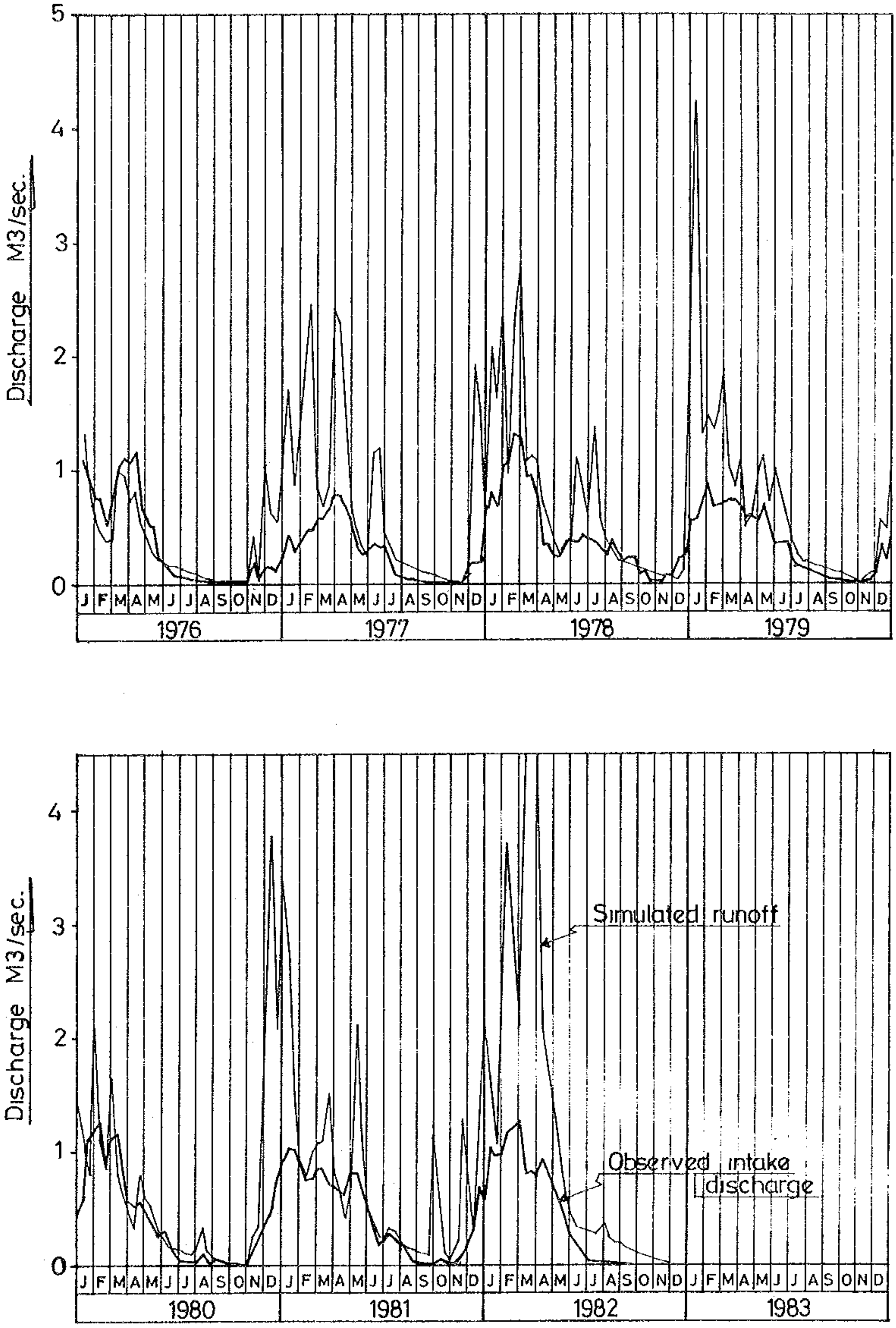

Fig. 14.3 COMPARISON BETWEEN SIMULATED RUNOFF AT KEDUNGWARAK AND INTAKE DISCHARGE OF SENGGOWAR.

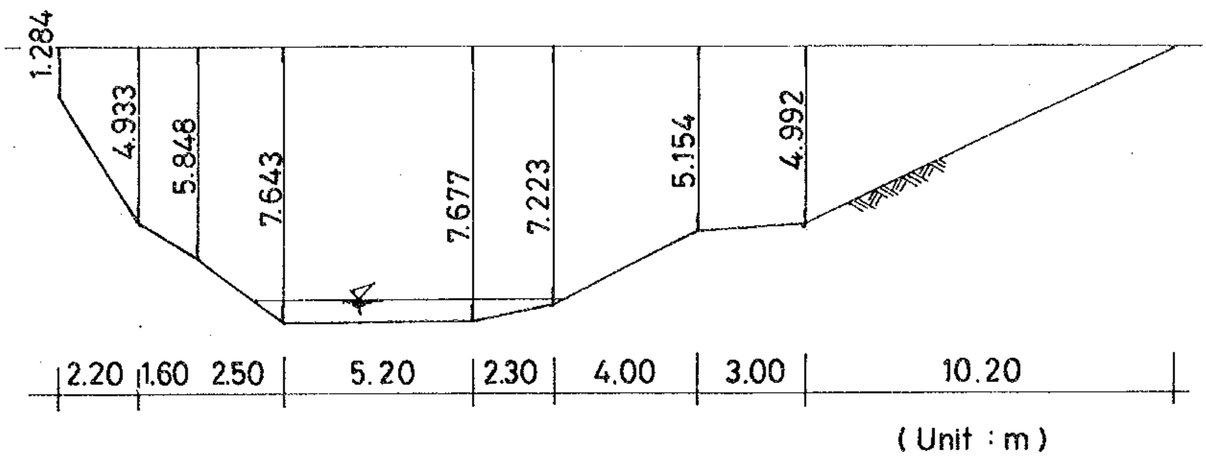

Fig. 14.4 CROSS SECTION OF KEDUNGWARAK RIVER AT GAUGING STATION

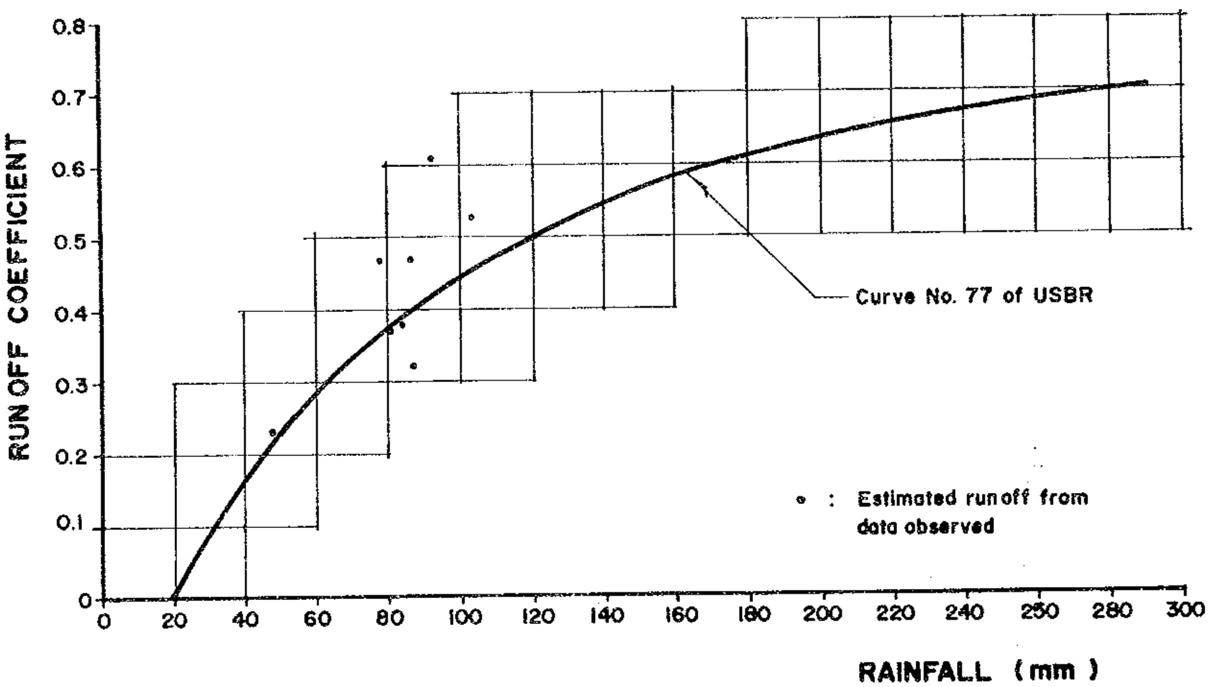

Fig. 14.5 RUNOFF COEFFICIENT ON KEDUNGWARAK RIVER

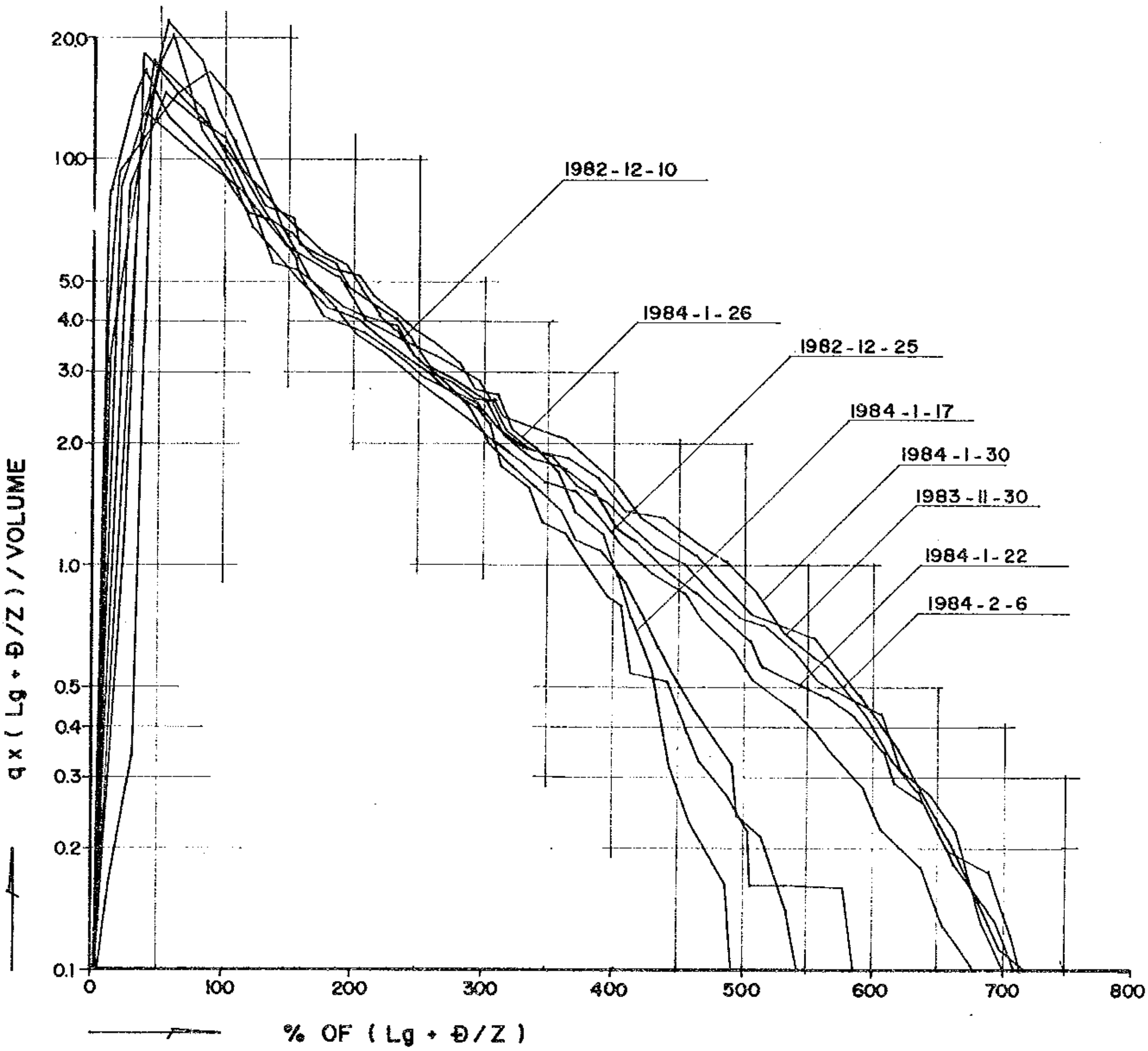

Fig. 14.6 DIMENSIONLESS HYDROGRAPH OF RECORDED FLOOD

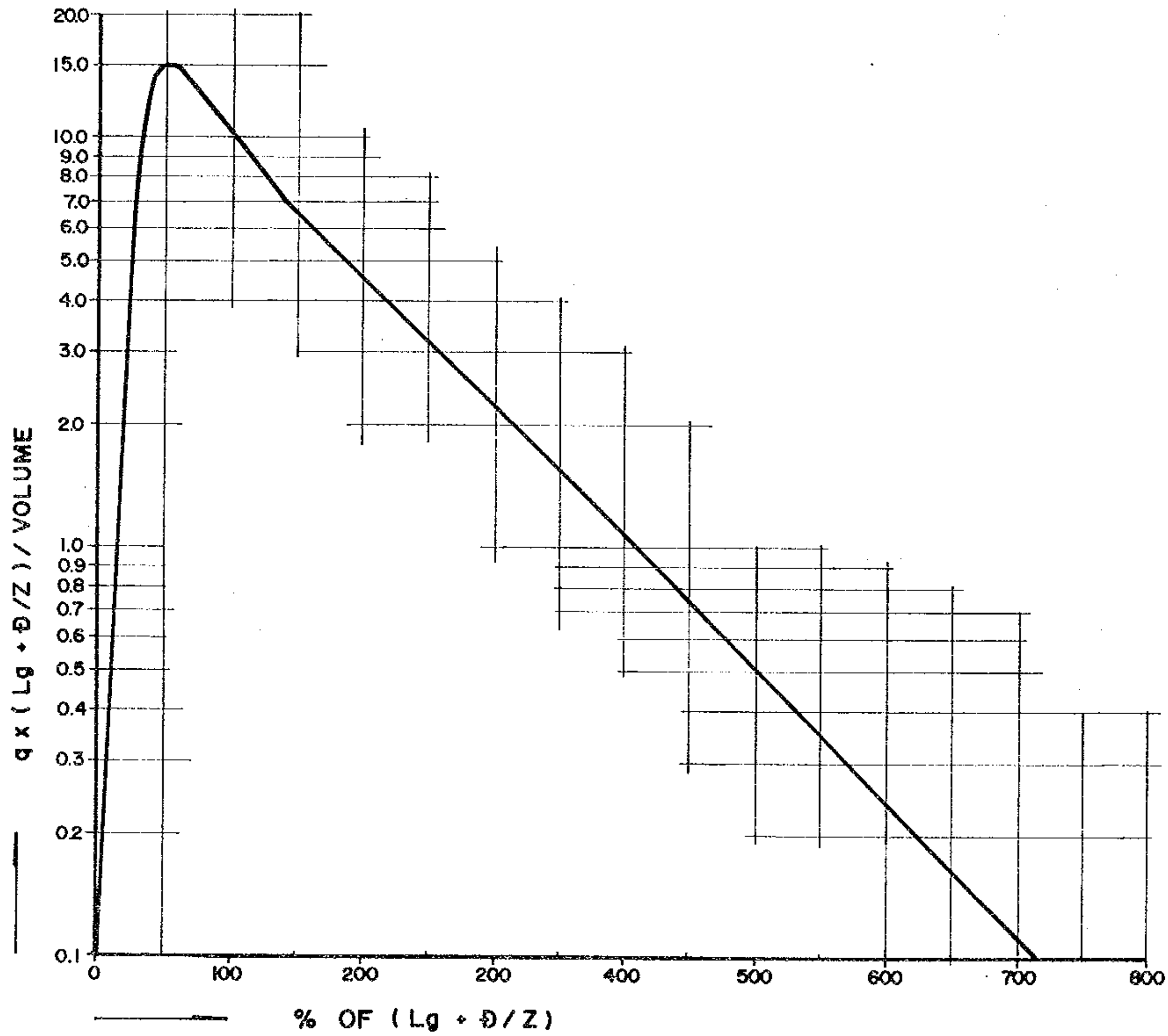

Fig. 14.7 DIMENSIONLESS HYDROGRAPH APPLIED FOR STUDY

CHAPTER 15 IRRIGATION WATER REQUIREMENT

LIST OF TABLES

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15. IRRIGATION WATER REQUIREMENT

Following calculation method and criteria are employed to estimate the irrigation water requirement.

15.1 Crop Water Requirement

15.1.1 Equation

Unit water requirement is calculated by the following equation:

$$I = CU + P + NR + L - ER$$

Where,
- I : unit water requirement
- CU : crop consumptive use of water
- P : percolation loss
- NR : nursery requirement
- L : puddling requirement
- ER : effective rainfall

15.1.2 Crop consumptive use of water (CU)

CPU is obtained as the products of potential evapo-transpiration (PET) and crop coefficient.

PET is estimated by the modified Penman method (FAO, Irrigation and Drainage Paper No. 24) by using the climatological data of Bulakmojo Station, Nganjuk. The climatological data are shown in Table 15.1 of ANNEX 2. The calculation results are as follows;

Unit: mm/day

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.5	4.7	4.6	4.2	4.1	4.1	4.5	4.9	5.8	5.7	5.2	4.7

Crop coefficients of both traditional and high yielding varieties of paddy are derived from PROSIDA/NEDECO Study. Actually the average crop coefficients between the traditional and high yielding varieties of paddy are used, because the traditional varieties still accounts for about 10% and the proportion is expected to increase in future assuming that some of high yield variety is replaced with traditional variety since the self-sufficiency of rice has already been attained, and Indonesian people demand for the traditional variety having a good taste.

Crop coefficients of polowijo and sugarcane are taken from the Irrigation and Drainage Paper No. 24, FAO. As for the water requirement calculation of polowijo, the average crop coefficients of soybean, maize and groundnuts are adopted. Fig. 15.1 shows the crop coefficients.

15.1.3 Percolation and land preparation

The percolation rate in the puddled field was tested by the staff of Brawijaya University. The results are shown in Table 15.2. The average is only 1 mm/day, however, the field percolation is usually more than the testing results due to the incomplete puddling and small animal holes etc. Therefore, for the estimate of water requirement, 2 mm/day is adopted.

15.1.4 Nursery requirement

The water requirement for nursery bed is estimated on the following assumptions.

Area required for nursery bed	:	5% of main field area
Nursery period	:	20 days
Percolation loss, 2 mm/day x 20 days	:	40 mm
Evapotranspiration	:	5 mm/day
Puddling requirement	:	125 mm (refer to next section).

15.1.5 Puddling requirement

Paddy fields require the water for puddling and preparation before transplanting young paddy. The water requirement of puddling is estimated as follows:

$$L = VP - MC + H$$

Where,
- L : Puddling requirement
- VP : Vapour phase
- MC : Moisture content before puddling
- H : Water depth in paddy field.

According to the soil test executed by the staff of Brawijaya University (refer to Soil Investigation Report), the pore space of soil is 59.5% as shown in Fig. 15.2. If the moisture content before puddling is supposed to be that of the hydro-scopic point, moisture content is 34.5% from Fig. 15.2. Therefore the water requirement to fill up the soil layer of 30 cm is 75 mm. In addition to the 75 mm, water depth standing in the paddy field is assumed to be required 50 mm. Thus the padding requirement of 125 mm is taken.

Besides, idling period of 10 days is considered between the commencement period of water supply and puddling time or between the puddling time and transplanting time, since the water supply, puddling works and transplanting works are not expected to be executed timely immediate after the foregoing works. The water requirement during the idling period is supposed to equal to the sum of evapotranspiration estimated by the modified Penman method and percolation rate.

15.1.6 Effective rainfall

The effective rainfall for paddy is estimated by simulating the plot-to-plot irrigation through ridges as shown in ANNEX 7 and compared with the traditional method. Fig. 15.3 shows the comparison between effective rainfalls estimated by both methods. As a results, the effective rainfall estimated by traditional method is close to those estimated by simulation analysis in case of two or three continuous plot case. Thus, the traditional method is applied for the estimate of overall effective rainfall.

The tradition method is as follows;

(i) Daily rainfall less than 5 mm is ineffective

(ii) 80% of daily rainfall ranging 5 mm to 80 mm is effective

(iii) Daily rainfall over 80 mm, 64 mm is effective.

The effective rainfall for upland crops is estimated on the following assumptions.

(i) Daily rainfall less than 5 mm is ineffective

(ii) 80% of daily rainfall ranging 5 mm to 37.5 mm is effective

(iii) Daily rainfall exceed 37.5 mm, 30 mm is effective

Total readily available moisture of 37.5 mm is obtained from the relation curve between moisture content and pF (see Fig. 15.2), applying the standard soil moisture extraction pattern with effective root zone of 60 cm, supposing that the available moisture is that between field capacity and temporary wilting point. The irrigation water is usually applied at the time when the available water of 37.5 mm is consumed. Thus, the rainfall of 37.5 mm is maximum as an effective rainfall.

However, it is of course that the effective rainfall estimated on the assumptions above exceeding the crop water requirement is ineffective.

For estimating the effective rainfall, the daily rainfall records of Lengkong station and Tretes station are used for each of Lengkong and Tretes areas. Estimated effective rainfalls are tabulated in ANNEX 7.

15.2 Irrigation Water Requirement

Irrigation water requirement is estimated by dividing the crop water requirement by irrigation efficiency. The irrigation efficiency consists of conveyance efficiency and field application efficiency. The conveyance efficiency is assumed to be 0.85 and the field application efficiency is to be 0.80 for paddy and 0.75 for upland crops by examining the on-going irrigation projects in the Brantas basin.

Sample calculation is shown in Table 15.3 and the calculation results for 30 yeas from 1954 to 1983 are listed in ANNEX 7.

Table 15.1 CLIMATE AT BULAKMOJO / NGANJUK

Location : EL. 50m, Latitude 7°35'45"
Londitude 111°55'06"

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature (°C)												
Max.	31.3	31.5	31.7	32.2	32.1	31.2	31.4	32.2	32.9	34.0	33.4	32.1
Min.	22.0	21.8	21.8	21.9	21.4	20.2	20.1	20.2	20.8	21.5	21.5	21.9
Mean	26.3	26.0	26.1	26.7	27.2	25.6	26.0	25.9	27.1	27.3	26.9	26.3
Humidity (%)	86.5	87.1	84.9	83.3	82.6	78.7	78.4	75.6	73.3	74.0	79.3	84.1
Wind Velocity (km/hr)	2.6	2.0	1.9	2.4	2.9	4.6	6.7	6.9	8.2	7.2	5.6	2.9
Sunshine Hours (8:00 - 16:00)	4.4	5.2	5.3	6.3	6.2	7.0	7.4	7.3	7.3	7.0	5.8	5.0

Note: Average of 11 years from 1973 to 1983

Table 15.2 PERCOLATION RATE AFTER PUDDLING

Name of Mapping Unit	No.of Sample	Percolation Rate (mm)
2	EH 5	0.4
5	BS 4	ponded ≑ 0.0
6	EH 4	2.4
7	BS 5	1.5
9	EH 1	0.4
10	EHS 1	0.4
11	EH 8	1.0
11	DSM 1	0.9
12	BS 2	2.1
13	BS 3	0.6
Average		1.0

Source : revised Interim Report for a Study of Soil Fertility Status in the Widas Basin (Brawijaya University, Center for Environmental Study,July 1985).

Table : 15.3 CROP WATER REQUIREMENT (1/2)

AREA NAME : WIDAS EXTENSION
PATTERN NAME : WET PADDY

YEAR ; 1974

MONTH	10-DAY	AF	KC	CU (MM)	P (MM)	CU+P (MM)	R (MM)	CU+P-R (MM)	PU (MM)	N (MM)	*AF (MM)	IR (MM)	Q (M*3/S)
JAN	1ST	.88	1.09	48.96	20	68.96	28	40.96	27.75	.79	35.84	64.38	1.1
	2ND	1	1.15	51.9	20	71.9	29.6	42.3	0	.25	42.3	42.55	.72
	3RD	1	1.22	60.57	22	82.57	76	6.57	0	0	6.57	6.57	.1
FEB	1ST	1	1.28	60.26	20	80.26	92.8	0	0	0	0	0	0
	2ND	1	1.31	61.78	20	81.78	18.4	63.38	0	0	63.38	63.38	1.08
	3RD	1	1.31	49.3	16	65.3	55.2	10.1	0	0	10.1	10.1	.21
MAR	1ST	.88	1.27	58.27	20	78.27	136.8	0	0	0	0	0	0
	2ND	.63	1.24	56.99	20	76.99	12	64.99	0	0	40.62	40.62	.69
	3RD	.38	1.2	60.66	22	82.66	23.2	59.46	0	0	22.3	22.3	.35
APR	1ST	.13	1.15	52.9	20	72.9	85.6	0	0	0	0	0	0
	2ND	0	0	0	0	0	113.6	0	0	0	0	0	0
	3RD	0	0	0	0	0	0	0	0	0	0	0	0
MAY	1ST	0	0	0	0	0	4.8	0	0	0	0	0	0
	2ND	0	0	0	0	0	62.4	0	0	0	0	0	0
	3RD	0	0	0	0	0	0	0	0	0	0	0	0
JUN	1ST	0	0	0	0	0	0	0	0	0	0	0	0
	2ND	0	0	0	0	0	0	0	0	0	0	0	0
	3RD	0	0	0	0	0	4.8	0	0	0	0	0	0
JUL	1ST	0	0	0	0	0	0	0	0	0	0	0	0
	2ND	0	0	0	0	0	4.8	0	0	0	0	0	0
	3RD	0	0	0	0	0	0	0	0	0	0	0	0
AUG	1ST	0	0	0	0	0	22.4	0	0	0	0	0	0
	2ND	0	0	0	0	0	0	0	0	0	0	0	0
	3RD	0	0	0	0	0	0	0	0	0	0	0	0
SEP	1ST	0	0	0	0	0	6.4	0	0	0	0	0	0
	2ND	0	0	0	0	0	28	0	0	0	0	0	0
	3RD	0	0	0	0	0	0	0	0	0	0	0	0
OCT	1ST	0	0	0	0	0	69.6	0	0	0	0	0	0
	2ND	0	0	0	0	0	12.8	0	0	0	0	0	0
	3RD	0	0	0	0	0	49.6	0	0	0	0	0	0
NOV	1ST	0	0	0	0	0	12.8	0	0	0	0	0	0
	2ND	0	0	0	0	0	67.2	0	0	0	0	0	0
	3RD	0	0	0	0	0	38.4	0	0	1.52	0	1.52	.03
DEC	1ST	.13	1	47	20	67	123.2	0	15.85	.79	0	16.64	.28
	2ND	.38	1.02	48.1	20	68.1	114.4	0	16.95	.85	0	17.8	.3
	3RD	.63	1.05	54.5	22	76.5	18.4	58.1	31.85	2.74	36.31	70.89	1.1
TOTAL		9	15.3	711.18	262	973.18	1311.2	345.86	92.4	6.94	257.41	356.75	5.96

NOTE: AF;AREA FACTOR : KC;CROP COEFFICIENT : CU;CONSUMPTIVE USE : P;PERCOLATION
R;EFFECTIVE RAINFALL : PU;PUDDLING REQUIREMENT : N;NURSERY REQUIREMENT
*AF=(CU+P-R)*AF : IR;NET IRRIGATION REQUIREMENT : Q;DIVERSION REQUIREMENT

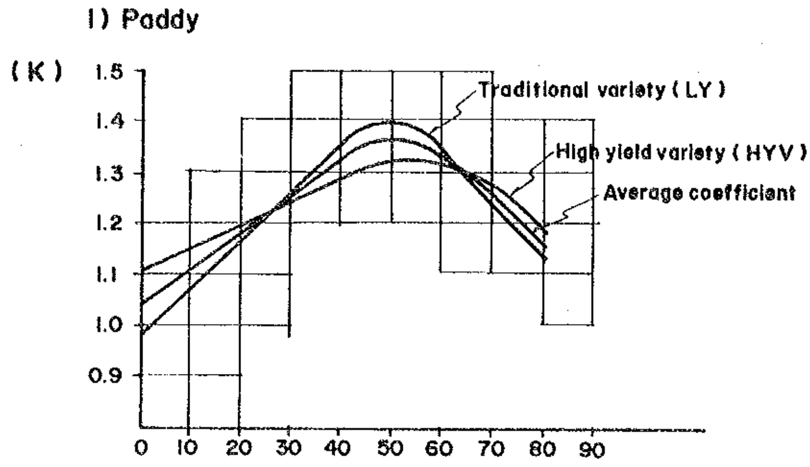
Table 15.3 CROP WATER REQUIREMENT (2/2)

AREA NAME : WIDAS EXTENSION
PATTERN NAME : DRY PADDY-1

YEAR ; 1974

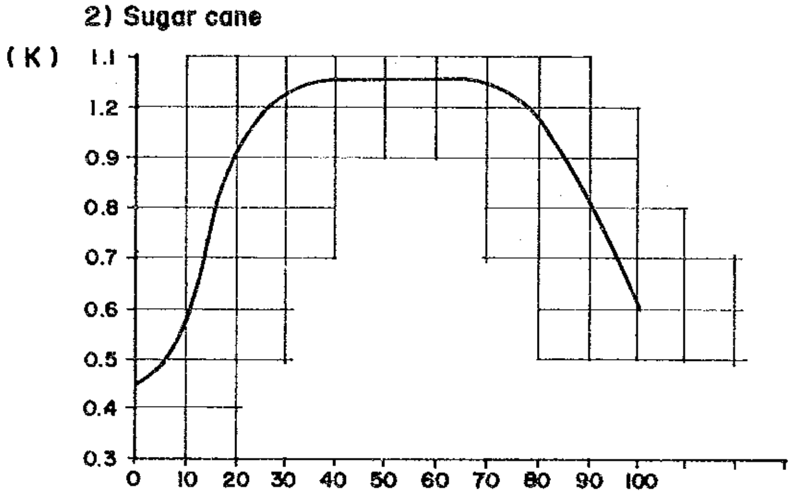
MONTH	10-DAY	AF	KC	CU (MM)	P (MM)	CU+P (MM)	R (MM)	CU+P-R (MM)	PU (MM)	N (MM)	*AF (MM)	IR (MM)	Q (M*3/S)
JAN	1ST	0	0	0	0	0	28	0	0	0	0	0	0
	2ND	0	0	0	0	0	29.6	0	0	0	0	0	0
	3RD	0	0	0	0	0	76	0	0	0	0	0	0
FEB	1ST	0	0	0	0	0	92.8	0	0	0	0	0	0
	2ND	0	0	0	0	0	18.4	0	0	0	0	0	0
	3RD	0	0	0	0	0	55.2	0	0	0	0	0	0
MAR	1ST	0	0	0	0	0	136.8	0	0	0	0	0	0
	2ND	0	0	0	0	0	12	0	0	0	0	0	0
	3RD	0	0	0	0	0	23.2	0	0	1.71	0	1.71	.03
APR	1ST	.13	1	46	20	66	85.6	0	20.55	1.03	0	21.58	.37
	2ND	.38	1.02	47.07	20	67.07	113.6	0	17.05	.85	0	17.9	.3
	3RD	.63	1.05	48.49	20	68.49	0	68.49	31.25	3.31	42.8	77.37	1.32
MAY	1ST	.88	1.09	45.7	20	65.7	4.8	60.9	30.65	1.22	53.29	85.16	1.45
	2ND	1	1.15	48.44	20	68.44	62.4	6.04	0	.05	6.04	6.09	.1
	3RD	1	1.22	56.53	22	78.53	0	78.53	0	0	78.53	78.53	1.22
JUN	1ST	1	1.28	52.57	20	72.57	0	72.57	0	0	72.57	72.57	1.24
	2ND	1	1.31	53.89	20	73.89	0	73.89	0	0	73.89	73.89	1.26
	3RD	1	1.31	53.76	20	73.76	4.8	68.96	0	0	58.96	68.96	1.17
JUL	1ST	.88	1.27	57	20	77	0	77	0	0	67.38	67.38	1.15
	2ND	.63	1.24	55.75	20	75.75	4.8	70.95	0	0	44.34	44.34	.75
	3RD	.38	1.2	59.35	22	81.35	0	81.35	0	0	30.5	30.5	.47
AUG	1ST	.13	1.15	56.35	20	76.35	22.4	53.95	0	0	6.74	6.74	.11
	2ND	0	0	0	0	0	0	0	0	0	0	0	0
	3RD	0	0	0	0	0	0	0	0	0	0	0	0
SEP	1ST	0	0	0	0	0	6.4	0	0	0	0	0	0
	2ND	0	0	0	0	0	28	0	0	0	0	0	0
	3RD	0	0	0	0	0	0	0	0	0	0	0	0
OCT	1ST	0	0	0	0	0	69.6	0	0	0	0	0	0
	2ND	0	0	0	0	0	12.8	0	0	0	0	0	0
	3RD	0	0	0	0	0	49.6	0	0	0	0	0	0
NOV	1ST	0	0	0	0	0	12.8	0	0	0	0	0	0
	2ND	0	0	0	0	0	67.2	0	0	0	0	0	0
	3RD	0	0	0	0	0	38.4	0	0	0	0	0	0
DEC	1ST	0	0	0	0	0	123.2	0	0	0	0	0	0
	2ND	0	0	0	0	0	114.4	0	0	0	0	0	0
	3RD	0	0	0	0	0	18.4	0	0	0	0	0	0
TOTAL		9	15.3	680.89	264	944.89	1311.2	712.62	99.5	8.17	545.05	652.72	10.94

NOTE: AF;AREA FACTOR : KC;CROP COEFFICIENT : CU;CONSUMPTIVE USE : P;PERCOLATION
R;EFFECTIVE RAINFALL : PU;PUDDLING REQUIREMENT : N;NURSERY REQUIREMENT
*AF=(CU+P-R)*AF : IR;NET IRRIGATION REQUIREMENT : Q;DIVERSION REQUIREMENT



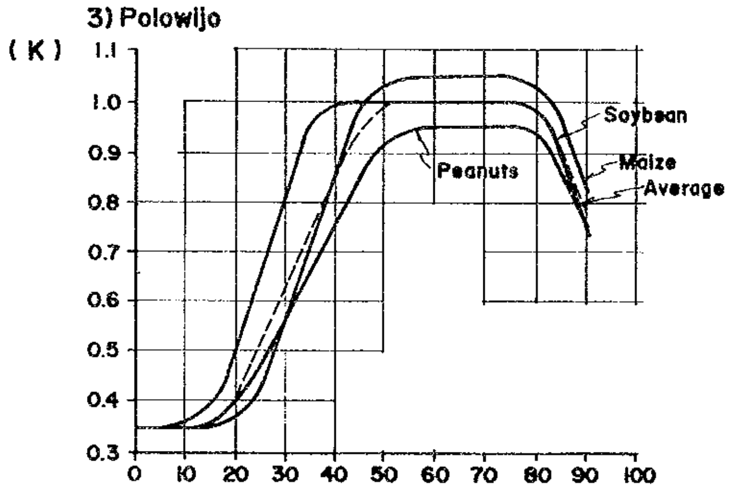
Soure : PROSIDA/NEDECO

Growing stage (%)



Source : FAO I/D paper No. 24

Growing stage (%)



Source : FAO I/D paper No. 24

Growing stage (%)

Fig. 15.1 CROP COEFFICIENT

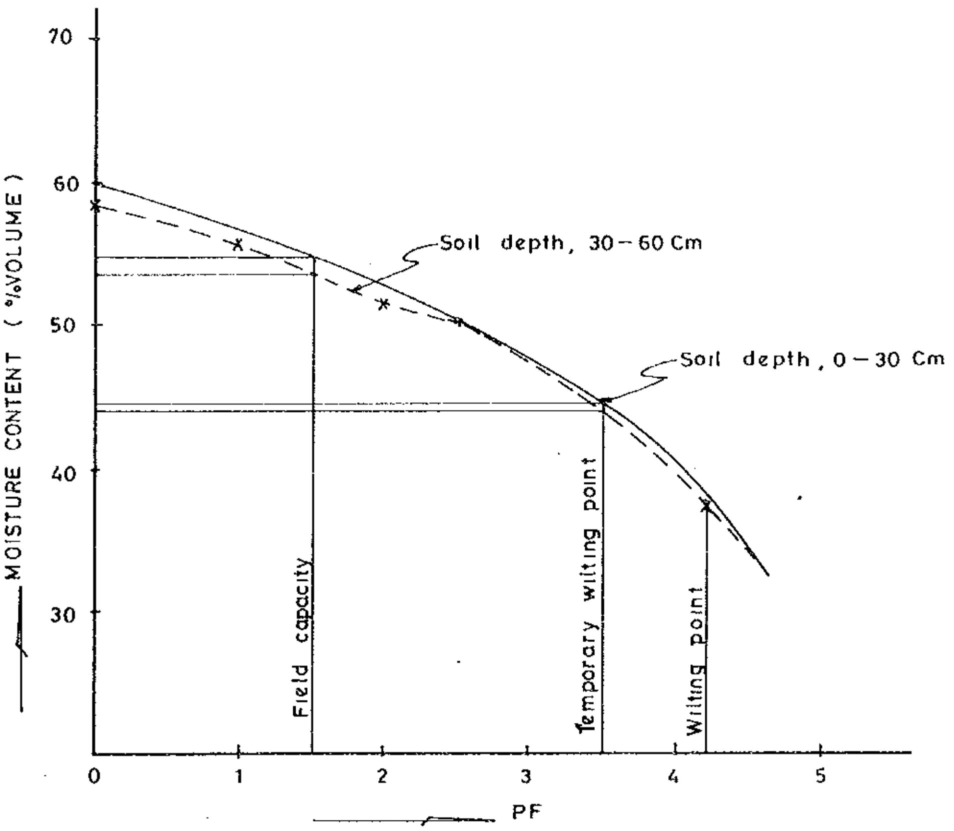


Fig: 15.2 RELATION BETWEEN MOISTURE CONTENT AND PF.

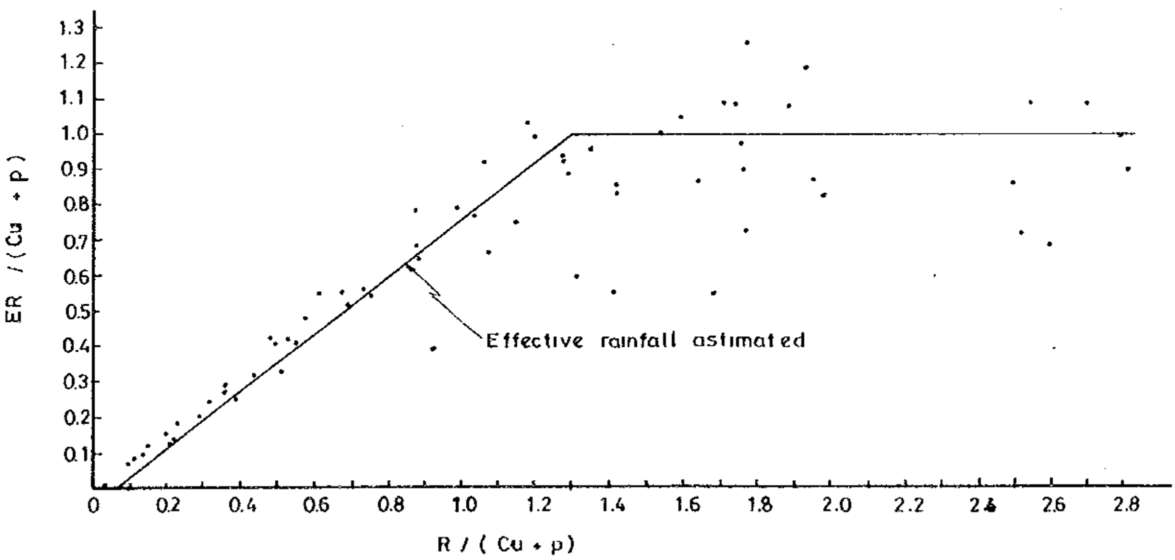


Fig: 15.3 COMPARISON BETWEEN EFECTIVE RAINFALLS ESTIMATED BY TRADITIONAL METHOD AND SIMULATION METHOD.
(TWO CONTINUOUS PLOT CASE)

CHAPTER 16 COMPARATIVE STUDY OF ALTERNATIVE

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16. COMPARATIVE STUDY OF ALTERNATIVE

16.1 Water Sources

As for the water sources for irrigation development in the Widas Extension Area, the surface water in the tributaries originating on the Kedung Ridge and the groundwater are potential sources.

The groundwater resources in the Widas Extension Area are limited since the aquifer is poorly developed and the recharge zone in the Kedung Ridge is narrow. The groundwater resources in the area have already been exploited to the believed maximum extent and there is no plan to expand the groundwater irrigation.

The surcace water can be divided into two; base flow and flood flow. Almost all the base flows in the tributaries both in the dry and wet seasons are utilized for irrigation. Flood flows of flushing nature have not been used owing to lack of storage facility. Therefore, the exploitable water resources for the Widas Extension Area are the flood flow in the wet season with interseasonal storage facilities. The sites suitable for interseasonal storage reservoir are found on the Kedungwarak river and the Ketandan river. At present the baseflow of the Kedungwarak river is utilized for the irrigation of the Senggowar area, which is a part of the previous Widas Project area and located in the downstream of the Kedungwarak river, together with irrigation supply from the Bening reservoir through the main canal, while water resources of tributaries of the Widas river flowing in parallel with the Kedungwarak river in the west side have been little utilized since the completion of the Bening reservoir and the main canal. Taking the above situations into account, the tributaries' water resources are proposed to be utilized for the Senggowar area through the existing main canal with provision of connecting canals and then the water resources of the Kedungwarak river will be used for the Widas Extension Area.

However, these tributaries are dried up in the dry season. Thus, the natural flow of the Kedungwarak river will be released to the Senggowar area as it is. According to the past intake records of the Senggowar area (see Annex-2), an amount upto 0.4 m^3/sec is to be released from the Kedungwarak site.

Based on the above considerations on the water resources, dam and irrigation plan is formulated.

For the water balance calculation to estimate the storage requirement, the water sources of the tributaries flowing through the extension area such as Tretes river, Senggon river, Sumberagung river, Sumber Kepuh river and Sumbersono river are taken into account based on the irrigation intake records in 1982 in addition to the Kedungwarak and Ketandan rivers.

16.2 Conceivable Alternatives

As being stated in the previous section, the dam and reservoir developments are conceivable on the Kedungwarak river and the Ketandan river. The Ketandan dam site is located in the east of the Kedungwarak site as shown in Fig.16.2. Since the altitude of the Ketandan basin is lower than that of the Kedungwarak basin, it is possible to divert the runoff of the Kedungwarak basin to the Ketandan basin through a trans-basin tunnel of about 1,500 m long.

Taking the above into account, the following two alternatives are considered for the irrigation development;

Alt. 1. Independent development of Kedungwarak dam and the irrigation area of Tretes district and Ketandan dam and irrigation area of Lengkong district with no connection by a trans-basin tunnel. (See Fig.16.1)

Alt. 2. Kedungwarak diversion weir, trans-basin tunnel, Ketandan dam and the irrigation area, so-called combined plan. (See Fig.16.2)

In both alternatives, the possibility of the irrigation application around the Kedungwarak reservoir is examined by topographic maps on a scale of 1 to 2,500 because the Ngluyu area is to provide the reservoir area but no returns are obtained by the project if the irrigation development is not formulated in this area. According to the examination using topographic maps, there is no room to be economically irrigated in case of alternative 1. On the contrary, in case of alternative 2, area of 128 ha can be irrigated. Thus, the 128 ha is incorporated into the objective development area.

Large scale development of the Kedungwarak dam with pumped-up storage planned in the Part I Study is very expensive and not economically justiable. Therefore, this scheme is excluded from the alternatives.

16.3 Criteria for Comparative Study

For selection of the optimum dam and irrigation development plan, the following requirements and criteria are taken into account.

1. Objective development area

As previously explained, the objective development area is fixed at possible maximum extent; 2,981 ha in the Widas Extension Area. In addition to the Widas Extension Area, 128 ha of Ngluyu area is incorporated in alternative 2.

2. Supply dependability

As for the supply dependability of irrigation water, 80% is taken, referring to the current criteria in Indonesia.

3. Carry-over

the natural flow varies year by year. If the reservoir is large enough, it is possible to control the flow not only inter-seasonally, but also inter-yearly (carry-over). However, such reservoir is expensive and difficult to operate. Therefore, the occurence of the carry-over is limited to the order of once in ten years.

4. Cropping pattern

For comparative study, the basic cropping pattern of paddy - polowijo - polowijo is applied. However, dry season paddy and sugarcane areas existing at present is kept as it is and irrigated with project condition. Tobacco cultivation area is left as it is with no irrigation water supply.

5. Construction costs

The construction costs are estimated based on the preliminary design and applying the provisional unit construction costs.

6. Incremental benefits

The benefits are estimated from the incremental crop productions of paddy, soybeans, maize, red onion and sugarcane at the projected 1990 economic prices at 1985 constant value.

7. Construction period

It is assumed that construction will take 3 years. The disbursement of the construction cost is assumed as 25%, 40% and 35% in the first, second and third year, respectively.

8. Project life time

The project life time of 50 years is assumed. The maturing period of the project is assumed as 3 years after completion of the project.