Appendix F

Water Demand Forecast for Agriculture

Appendix F
Water Demand Forecast for Agriculture

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Appendix F Water Demand Forecast for Agriculture

1. IRRIGATION WATER DEMAND

1.1 Methodology

(1) Collection of Data and Information

i) General features of existing projects (name, location, area, etc.)

ii) General features of existing water source facilities (dam/reservoir, headworks, etc.)

iii) Present cropping patterns

iv) Present discharges of intakes for existing irrigation systems

v) Criteria on irrigation water requirement

- Common formula in Vietnam for potential evapotranspiration
- Common method in Vietnam for estimation of effective rainfall
- Common value in Vietnam of irrigation efficiency
- Common value in Vietnam of unit irrigation water requirement (l/sec/ha)

vi) Latest water source facilities development plans (dam/reservoir, headworks, etc.)

vii) Latest irrigation, drainage and farm road development plans

(2) Cultivated Land Area and Planted Area

Present and future cultivated land area and crop planted area have been estimated with reference to the following documents, etc.:

a) Strategies for Agriculture and Rural Development in 2001 - 2010 Summary, MARD, FAO, May 2000

b) Agriculture - Forestry - Fishery and Rural Development Plan for 2001 - 2005 Period, Dept. of Agriculture and Rural Development MPI, November 2000

c) Agriculture in Vietnam - 61 Provinces and Cities, MARD, NIAPP, 2001

(3) Cropping Pattern

Present and future cropping pattern have been set up with reference to the following documents, etc.:

a) The Sector Review Study for the Water Resources Development ANNEX Inventory of Water Resources Project, Nippon Koei Co., Ltd., August 1992

b) The Feasibility Study on Ta Trach Project in the Thua Thien Hue Province INTERIM REPORT, HEC, December 1999

(4) Irrigation Area

Present and future irrigation areas have been estimated with reference to the following documents, etc.,

a) Answers to Questionnaire on Irrigation Development (from Provinces to JICA Study Team)

b) The Sector Review Study for the Water Resources Development ANNEX Inventory of Water Resources Project, Nippon Koei Co., Ltd., August 1992

c) Profiles for river basins, World Bank - Vietnam Water Resources Assistance Program, October 2000

d) Main Report, Vietnam Water Resources Sector Review, World Bank, ADB, FAO, UNDP, NGOs, IWRP, May 1996

(5) Potential Evapotranspiration (ETo)

The monthly potential evapotranspiration (ETo mm/month) at the respective areas concerned have been obtained from the Vietnam Hydrometeorological ATLAS, 1994.

Besides, with reference to the following documents, the monthly potential evapotranspiration (ETo) in ATLAS has been reviewed:

a) ESCAP Water Resources Series No.65 Guidelines for the Preparation of National Master Water Plans, UN, 1989

b) FAO Irrigation and Drainage Paper 24 revised 1977 Guidelines for Predicting Crop Water Requirements, 1977

c) REPORT Expert Consultation on Revision of FAO Methodologies for Crop Water Requirements, FAO, 1990

d) FAO Irrigation and Drainage Paper 46 CROPWAT, A Computer Program for Irrigation Planning and Management, 1992

e) FAO Irrigation and Drainage Paper 56 Crop Evapotranspiration Guidelines for Computing Crop Water Requirements, 1998

The Modified Penman Method has finally been adopted to be used for estimation of ETo to compare with the values in the ATLAS. As a result, both values of the estimation and the ATLAS are quite similar each other.

In the above estimation, the following meteorological data in the ATLAS were used:

- Mean air temperature (°C)
- Relative humidity (%)
- Wind velocity (m/sec)
- Sunshine hours (hr)

The calculation result of ETo (mm/month) with the Modified Penman Method and ETo (mm/month) of ATLAS are shown together in Table F.1. It could be known that the ATLAS values are almost equivalent to ones that are calculated with the adjustment factor to compensate for effect of day and night weather conditions (c) is one, namely c = 1, as conducted in the original Penman method. In conclusion, it has been judged that the ATLAS's ETo (mm/month) shown in Table F.2 could be applied for this Study.

The above ETo (mm/month) was divided into three (3) pieces of 10-day ETo (mm/10-day) and used for calculation of crop water requirement to let them suit the variation of crop growing degree or crop coefficient value described hereinafter.

(6) Crop Coefficient (Kc)

The crop coefficients (Kc) of the various crops concerned have been estimated with reference to the following documents:

a) FAO Irrigation and Drainage Paper 33 Yield Response to Water, 1979

b) FAO Irrigation and Drainage Paper 56 Crop Evapotranspiration Guidelines for Computing Crop Water Requirements, 1998

Different Kc values were taken for the respective development stages:

- Initial stage
- Crop development stage
- Mid-season stage
- Late season stage
- Stage at harvest

With use of the Kc values, crop coefficient curves have been drawn for the respective crops. Value of Kc at each growing time has been read from the curve.

(7) Crop Water Requirement (CWR)

Crop water requirement (CWR) or crop evapotranspiration (ETc) of the various crops concerned have been estimated as follows:

$$CWR = ETc = ETo \times Kc$$

where, CWR: Crop water requirement (mm/10-day)
ETc: Crop evapotranspiration (mm/10-day)
ETo: Potential evapotranspiration (mm/10-day)

Kc: Crop coefficient (see Figure F.1)

This is directly used as consumptive use of water of upland crops that are ones except paddy rice.

(8) Consumptive Use of Water of Crops (CUW)

(a) Paddy rice

i) Percolation loss (P)

As for the paddy rice, the percolation loss (P mm/day) has been estimated with reference to the following:

FAO Irrigation and Drainage Paper 46 CROPWAT, A Computer Program for Irrigation Planning and Management, 1992

The percolation loss has been determined as follows:

P = 2 mm/day
= 16 mm/8 days or 20 mm/10 days or 22 mm/11days

It is noted that a past report of MARD also used the percolation loss of 2 mm/day because no experimental data for its project area was found at the time.

ii) Land preparation water requirement (LPW)

Besides, water requirement for the land preparation (LPW) for paddy fields is to be included in CUW for the period before sowing seeds or transplanting seedlings. With reference to the previous report of MARD, the following conditions have been applied for estimation of LPW:

LPW = (LS + SW) + Ep + P

where, LPW: Land preparation water requirement (mm/10-day)

LS: Land soaking water (mm/10-day)
LS=10mm/20days for wet time
LS=100mm/20days for dry time
The above LS mm/20days is to be converted into LS mm/10-day.

SW: Standing water requirement (mm/10-day)
SW=50mm/20days
The above SW mm/20days is to be converted into SW mm/10-day.

Evp: Evaporation from open water surface (mm/10-day)
Evp = ETo x 1.1

P: Percolation loss (mm/10-day)

The above-mentioned condition is shown in Figure F.2.

iii) Consumptive use of water of paddy rice field (CUW)

The consumptive use of water (CUW mm/10-day) of the paddy rice field has been calculated as follows:

CUW = CWR + P for growing period

CUW = LPW for land preparation period

where, CUW: Consumptive use of water (mm/10-day)

CWR: Crop water requirement (mm/10-day)

P: Percolation loss (mm/10-day)

LPW: Land preparation water requirement (mm/10-day)

(b) Upland crops

The consumptive use of water is expressed as follows:

CUW = CWR

where, CUW: Consumptive use of water of crop (mm/10-day)

CWR: Crop water requirement (mm/10-day)

(9) Effective Rainfall (Peff)

For estimation of effective rainfall, the following were referred to:

a) FAO Irrigation and Drainage Paper 25 Effective Rainfall, 1974

b) FAO Irrigation and Drainage Paper 46 CROPWAT, A Computer Program for Irrigation Planning and Management, 1992

In consideration of required accuracy and practical convenience, it has been determined to adopt the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Method, which is shown in the FAO Irrigation and Drainage Paper 46 mentioned above.

In the method, the effective rainfall is calculated on the monthly basis.

Peff = Ptot x (125 - 0.2Ptot) / 125 for Ptot =< 250 mm

Peff = 125 + 0.1Ptot for Ptot > 250 mm

where, Peff: Effective rainfall (mm/month)

Ptot: Monthly rainfall (mm/month)

Therefore, the above Peff (mm/month) has been divided into three (3) 10-day basis effective rainfalls Peff (mm/10-day) like the ETo (mm/10-day) case.

(10) Net Irrigation Water Requirement (NIR)

The net irrigation water requirement (NIR mm/10-day) has been calculated as follows:

NIR = CUW - Peff

where, NIR: Net irrigation requirement (mm/10-day)
CUW: Consumptive use of water of crop (mm/10-day)
Peff: Effective rainfall (mm/10-day)

A weighted average of NIR of the respective crops with use of their planted areas has been calculated to obtain an average value for the whole area.

(11) Irrigation Efficiency (Ep)

For estimation of irrigation efficiency, the following were referred to:

a) FAO Irrigation and Drainage Paper 24 revised 1977 Guidelines for Predicting Crop Water Requirements, 1977

b) FAO Irrigation and Drainage Paper 46 CROPWAT, A Computer Program for Irrigation Planning and Management, 1992

The irrigation efficiency has been determined as follows:

Ep = Ea x Eb x Ec

where, Ep: Project efficiency
Ea: Field application efficiency
Eb: Field canal efficiency
Ec: Conveyance efficiency

Item	Less-managed System (Year 2000)	Ordinary System (Year 2010)	Well-managed System (Year 2020)
Ea	0.78	0.80	0.82
Eb	0.88	0.90	0.92
Ec	0.87	0.90	0.93
Ep	0.60	0.65	0.70

Ref. Table 37 of FAO Paper 24

Ep of 0.60 has been applied for the present water demand, and 0.65 for 2010 and 0.70 for 2020 respectively for the future water demands in the Study.

The above have been set for the purpose of irrigation water demands for the 14 river basins at the accuracy of preliminary study level.

(12) Gross Irrigation Requirement (GIR)

The gross irrigation water requirement has been estimated as follows:

GIR = NIR / Ep

where, GIR: Gross irrigation water requirement (mm/10-day)

NIR: Net irrigation water requirement (mm/10-day)

Ep: Irrigation efficiency (project efficiency)

The gross irrigation water requirement GIR (mm-10 day) has been converted into GIR (l/sec/ha) and been used for the water balance calculation.

(13) Irrigation Water Demand (IWD)

The irrigation water demand has been estimated as follows:

IWD = GIR x A / 1,000

where, IWD: Irrigation water demand (m^3/sec)

GIR: Gross irrigation water requirement (lit/sec/ha)

A: Irrigation area (ha)

1.2 Forecast of Irrigation Water Demand

1.2.1 Gross Unit Irrigation Requirement (GIR)

Two kinds of gross unit water requirements (GIR) are explained hereinafter. One is GIR in a 1/4 drought year and another is GIR in the average rainfall year.

Peak GIR is used for the facilities design. The required storage volume of the reservoir and the capacity of irrigation facilities would be determined under condition of dependable rainfall with 1/4 probability. In more detail, for example, a peak 10-day GIR in the 1/4 drought year would be used for the design of irrigation canals and structures.

On the other hand, GIR in the average rainfall year is used to know the irrigation water demand (IWD) on an average. For example, total IWD in a ten-year period is known through the calculation of multiplying the IWD in the average rainfall year by 10. Monthly GIRs in the average rainfall year are used to estimate the IWD.

Summary of these two kinds of GIR for the 14 river basins is presented hereinafter.

(1) GIR in 1/4 drought year

Gross unit water requirements (GIR) of the 14 river basins in the respective 1/4 drought years have been estimated based on the present and future conditions of cropping patterns and irrigation areas as below.

It is noted that there are two (2) kinds of 1/4 drought year to be separately used case by case. One is selected from ranking of the peak 10-day GIR (annual maximum) and another is from ranking of the water shortage volume calculated in the water balance calculation.

Gross Unit Irrigation Water Requirement (GIR)
-1/4 Drought Year **selected from Peak 10-day GIR-**

River Basin	Year	Present (2001)		Future (2010)		Future (2020)	
		Peak 10-day l/sec/ha	Annual Total m^3/yr/ha	Peak 10-day l/sec/ha	Annual Total m^3/yr/ha	Peak 10-day l/sec/ha	Annual Total m^3/yr/ha
01. Bang Giang	1993	1.17*	14,000*	0.80	8,600	0.73	7,700
02. Red	1981	1.22	14,100	1.12	13,000	1.02	11,900
03. Ma	1982	1.19*	12,300*	0.82	10,000	0.72	9,300
04. Ca	1977	1.42	15,400	1.07	11,600	0.92	9,900
05. Thach Han	1982	1.48	19,600	1.15	15,600	1.02	13,900
06. Huong	1991	1.24	12,200	1.22	11,800	1.48	13,500
07. Thu Bon	1993	1.17	13,600	0.91	10,800	0.81	9,700
08. Tra Khuc	1976	1.09*	11,700*	0.90	13,300	0.76	10,600
09. Kone	1985	1.76*	28,200	1.74	23,200	1.67	19,800
10. Ba	1982	1.97	20,700	1.41	13,900	1.24	12,000
11. Sesan	1988	0.73*	10,900*	0.88	9,400	0.85	8,700
12. Srepok	1995	1.25	14,200	1.11	11,800	1.03	10,700
13. Dong Nai	1984	1.64*	19,500*	1.00*	13,100*	0.72	9,700
14. Cuu Long Delta	1981	2.27	20,900	1.92	18,300	1.69	16,200

Note. Mark of * shows the peak GIR of 1/4 probability that is caused in a different year from the above.

The capacity of irrigation facilities such as intake structures, canals and related structures would be determined with use of the above peak 10-day GIR. This is not a matter of the water demand (volume of water) but of the peak unit water requirement to calculate the design discharges of the facilities. The peak 10-day GIR would be used for design of the facilities.

Gross Unit Irrigation Water Requirement (GIR)
-1/4 Drought Year selected from Water Balance-

River Basin	Year	Present (2001)		Future (2010)		Future (2020)	
		Peak 10-day l/sec/ha	Annual Total m^3/yr/ha	Peak 10-day l/sec/ha	Annual Total m^3/yr/ha	Peak 10-day l/sec/ha	Annual Total m^3/yr/ha
01. Bang Giang	1987	1.17	14,000	0.77	9,500	0.71	8,500
02. Red	1974	1.05	13,600	0.96	12,500	0.87	11,500
03. Ma	1998	1.06	15,300	0.80	12,500	0.70	11,600
04. Ca	1976	1.37	16,200	1.03	12,200	0.88	10,400
05. Thach Han	1998	1.53	18,500	1.20	14,700	1.06	13,100
06. Huong	1993	1.21	15,100	1.19	14,500	1.45	16,100
07. Thu Bon	1990	1.00	11,400	0.79	9,000	0.69	8,000
08. Tra Khuc	1982	0.96	14,600	0.89	11,800	0.74	9,400
09. Kone	1988	1.91	29,200	1.78	24,700	1.70	21,100
10. Ba	1985	1.89	21,200	1.48	14,200	1.31	12,200
11. Sesan	1994	0.66	9,800	0.83	10,200	0.80	9,500
12. Srepok	1995	1.25	14,200	1.11	11,800	1.03	10,700
13. Dong Nai	1984	1.64	19,500	1.00	13,100	0.72	9,700
14. Cuu Long Delta	1981	2.27	20,900	1.92	18,300	1.69	16,200

The above 1/4 drought years of the respective river basins have been determined through the water balance analysis for the period from 1976 to 2000 (different number of years, for example 24 years, etc., have been used for some river basins depending upon the data

availability).

Monthly GIRs (lit/sec/ha) for the 25-year period of the 14 river basins are shown in DATA BOOK.

For example, the monthly GIRs (lit/sec/ha) for the 25-year period of the Kone River Basin are shown in Tables F.3 through F.5.

The required storage volumes of the reservoirs have been estimated through the monthly water balance for the 25-year period.

Calculation process of all the above-shown peak 10-day GIRs (lit/sec/ha) and annual total GIRs (m^3/year/ha) are shown in DATA BOOK.

Calculation process of the above-shown peak 10-day GIRs (lit/sec/ha) and annual total GIRs (m^3/year/ha) of the Kone River Basin are shown in Tables F.6 through F.8 attached hereto.

The capacity of irrigation facilities such as intake structures, canals and related structures would be determined with use of the peak 10-day GIR. This is not a matter of the water demand (volume of water) but of the peak unit water requirement to calculate the design discharges of the facilities. The peak 10-day GIR would be used in something like feasibility studies for design of the facilities with major dimensions to be shown.

(2) GIR in Average Rainfall Year

Gross unit water requirements (GIR) of the 14 river basins estimated based on the present and future conditions of cropping patterns and irrigation areas in the average rainfall year are shown in the table below.

The average rainfalls used in the calculation have been taken from the Vietnam Hydro-meteorological ATLAS, 1994, which are shown in Table F.9.

Gross Unit Irrigation Water Requirement (GIR)
Average Rainfall Year

River Basin	Present (2001)		Future (2010)		Future (2020)	
	Annual Average lt/sec/ha	Annual Total m^3/yr/ha	Annual Average lt/sec/ha	Annual Total m^3/yr/ha	Annual Average lt/sec/ha	Annual Total m^3/yr/ha
01. Bang Giang	0.33	10,600	0.22	6,800	0.19	6,100
02. Red	0.42	13,100	0.38	12,100	0.35	11,100
03. Ma	0.38	11,800	0.30	9,400	0.28	8,800
04. Ca	0.38	11,900	0.28	8,900	0.24	7,500
05. Thach Han	0.46	14,500	0.36	11,200	0.32	10,000
06. Huong	0.38	12,100	0.37	11,700	0.41	13,000
07. Thu Bon	0.37	11,600	0.29	9,200	0.26	8,200
08. Tra Khuc	0.39	12,300	0.31	9,800	0.24	7,700
09. Kone	0.86	27,100	0.73	23,000	0.62	19,600
10. Ba	0.64	20,300	0.43	13,600	0.37	11,700
11. Sesan	0.26	8,100	0.27	8,600	0.25	7,900
12. Srepok	0.45	14,100	0.37	11,600	0.34	10,600
13. Dong Nai	0.68	21,500	0.40	12,600	0.30	9,600
14. Cuu Long Delta	0.62	19,600	0.54	17,100	0.48	15,100

The above GIRs in the average rainfall year would be used when we need to calculate the water demand in discharge (m^3/sec) or in volume (million m^3/year) to be supplied for the irrigation sector.

Monthly GIRs (lit/sec/ha) of the 14 river basins in the average rainfall year are shown in Tables F.10 through F.12.

Calculation processes of the all above annual average GIRs (lit/sec/ha) and annual total GIRs (m^3/year /ha) are shown in DATA BOOK.

For example, calculation process of the above-shown annual average GIRs (lit/sec/ha) and annual total GIRs (m^3/year /ha) of the Kone River Basin are shown in Tables F.13 through F.15 attached hereto.

1.2.2 Irrigation Water Demand (IWD)

(1) IWD in 1/4 Drought year

Irrigation water demands (IWDs) of the 14 river basins estimated based on the present and future conditions of cropping patterns and irrigation areas in the 1/4 drought years of the respective basins are as follows:

Irrigation Water Demand (IWD)
1/4 Drought Year selected from Water Balance

River Basin	Year		Present(2001)	Future (2010)	Future (2020)
01. Bang Giang	1987	Area (ha)	25,500	54,500	67,500
Water Demand		(m^3 / sec)	11.3	16.4	18.3
		(10^6 m^3 / yr.)	360	520	580
02. Red	1974	Area (ha)	1,008,000	1,197,000	1,291,000
Water Demand		(m^3 / sec)	433.7	475.9	469.7
		(10^6 m^3 / yr.)	13,680	15,010	14,810
03. Ma	1998	Area (ha)	112,000	176,000	199,500
Water Demand		(m^3 / sec)	54.4	69.7	73.2
		(10^6 m^3 / yr.)	1,720	2,200	2,310
04. Ca	1976	Area (ha)	93,000	150,000	203,000
Water Demand		(m^3 / sec)	47.6	58.0	66.7
		(10^6 m^3 / yr.)	1,500	1,830	2,100
05. Thach Han	1998	Area (ha)	5,000	12,300	15,400
Water Demand		(m^3 / sec)	2.9	5.7	6.4
		(10^6 m^3 / yr.)	90	180	200
06. Huong	1993	Area (ha)	25,900	25,900	25,900
Water Demand		(m^3 / sec)	12.4	11.9	13.2
		(10^6 m^3 / yr.)	390	380	420
07. Thu Bon	1990	Area (ha)	30,900	69,000	77,000
Water Demand		(m^3 / sec)	11.2	19.7	19.5
		(10^6 m^3 / yr.)	350	620	620
08. Tra Khuc	1982	Area (ha)	33,000	42,000	54,000
Water Demand		(m^3 / sec)	15.2	15.7	16.1
		(10^6 m^3 / yr.)	480	500	510
09. Kone	1988	Area (ha)	25,000	36,500	49,000
Water Demand		(m^3 / sec)	23.1	28.6	32.8
		(10^6 m^3 / yr.)	730	900	1,040
10. Ba	1985	Area (ha)	41,000	129,000	186,000
Water Demand		(m^3 / sec)	27.5	58.1	72.2
		(10^6 m^3 / yr.)	870	1,830	2,280
11. Sesan	1994	Area (ha)	22,500	35,400	50,000
Water Demand		(m^3 / sec)	7.0	11.4	15.1
		(10^6 m^3 / yr.)	220	360	480
12. Srepok		Area (ha)	29,000	35,000	91,000
Water Demand	1995	(m^3 / sec)	13.0	13.0	31.0
		(10^6 m^3 / yr.)	410	410	980
13. Dong Nai	1984	Area (ha)	115,000	255,000	393,000
Water Demand		(m^3 / sec)	70.2	100.5	120.4
		(10^6 m^3 / yr.)	2,210	3,170	3,800
14. Cuu Long Delta	1981	Area (ha)	1,487,000	1,891,000	2,242,000
Water Demand		(m^3 / sec)	983.8	1,095.0	1,153.3
		(10^6 m^3 / yr.)	31,030	34,530	36,370

The above 1/4 drought years of the respective river basins have been determined through the water balance analysis for the 25-year period.

Monthly IWDs (m^3/sec) for the 25-year period of the 14 river basins are shown in DATA BOOK.

It is noted that the monthly IWDs (m^3/sec) shown in those tables, which are river basin totals, have not been directly used for the water balance analysis to seek the 1/4 drought year and to estimate the required storage volumes of the reservoirs. For this purpose, the monthly GIRs (lit/sec/ha) have been used as mentioned previously.

In more concretely describing, monthly diversion discharges from January to December at each intake point on the water balance model have been calculated with multiplying each irrigation area (ha) by the monthly GIRs (lit/sec/ha).

In such a sense, the above-mentioned monthly IWDs (m^3/sec) might be referred to just to get an image of the necessary water in the 1/4 drought with the total discharge (m^3/sec) for the whole irrigation area (ha) in each river basin.

(2) IWD in Average Rainfall Year

Irrigation water demands (IWDs) of the 14 river basins estimated based on the present and future conditions of cropping patterns and irrigation areas in the average rainfall year are as follows:

Irrigation Water Demand (IWD)
Average Rainfall Year

River Basin		Present(2001)	Future(2010)	Future(2020)
01. Bang Giang	Area (ha)	25,500	54,500	67,500
Water Demand	(m^3 / sec)	8.5	11.8	13.0
	(10^6 m^3 / year)	270	370	410
02. Red	Area (ha)	1,008,000	1,197,000	1,291,000
Water Demand	(m^3 / sec)	419.0	459.9	453.9
	(10^6 m^3 / year)	13,220	14,510	14,320
03. Ma	Area (ha)	112,000	176,000	199,500
Water Demand	(m^3 / sec)	42.0	52.6	55.4
	(10^6 m^3 / year)	1,330	1,660	1,750
04. Ca	Area (ha)	93,000	150,000	203,000
Water Demand	(m^3 / sec)	35.2	42.3	48.2
	(10^6 m^3 / year)	1,110	1,330	1,520
05. Thach Han	Area (ha)	5,000	12,300	15,400
Water Demand	(m^3 / sec)	2.3	4.4	4.9
	(10^6 m^3 / year)	70	138	154
06. Huong	Area (ha)	25,900	25,900	25,900
Water Demand	(m^3 / sec)	9.9	9.6	10.7
	(10^6 m^3 / year)	310	300	340
07. Thu Bon	Area (ha)	30,900	69,000	77,000
Water Demand	(m^3 / sec)	11.4	20.1	19.9
	(10^6 m^3 / year)	360	640	630
08. Tra Khuc	Area (ha)	33,000	42,000	54,000
Water Demand	(m^3 / sec)	12.8	13.1	13.1
	(10^6 m^3 / year)	410	410	410
09. Kone	Area (ha)	25,000	36,500	49,000
Water Demand	(m^3 / sec)	21.5	26.6	30.4
	(10^6 m^3 / year)	680	840	960

10. Ba	Area (ha)	41,000	129,000	186,000
Water Demand	(m^3 / sec)	26.4	55.4	68.9
	(10^6 m^3 / year)	830	1,750	2,170
11. Sesan	Area (ha)	22,500	35,400	50,000
Water Demand	(m^3 / sec)	5.8	9.6	12.6
	(10^6 m^3 / year)	180	300	400
12. Srepok	Area (ha)	29,000	35,000	91,000
Water Demand	(m^3 / sec)	13.0	12.9	30.5
	(10^6 m^3 / year)	410	410	960
13. Dong Nai	Area (ha)	115,000	255,000	393,000
Water Demand	(m^3 / sec)	78.5	101.7	119.2
	(10^6 m^3 / year)	2,480	3,210	3,760
14.Cuu Long Delta	Area (ha)	1,487,000	1,891,000	2,242,000
Water Demand	(m^3 / sec)	923.9	1,023.8	1,075.9
	(10^6 m^3 / year)	29,140	32,290	33,940

The above IWDs in the average rainfall year would be usually used when we need to indicate the water demand or irrigation water consumption of the respective 14 river basins in discharge (m^3/sec) or in volume (million m^3/year). Then, we would know how much ratio of the water is allocated to the irrigation sector in comparison with the other sectors on the same basis. That is the water demand on an average, which is recognized as the average of water demands in various years such as those in high water consumption years (dry years), ordinary consumption years and low consumption years (wet years).

Monthly IWDs (m^3/sec) of the 14 river basins are shown in Tables F.10 through F.12 together with the monthly GIRs (lit/sec/ha).

1.3 Examination of Irrigation Water Demand in Srepok River Basin

(1) General

It has been examined through the water balance calculations for the respective river basins that 13 river basins except the Srepok River Basin would have sufficient water supply to meet the water irrigation demands estimated in accordance with the required irrigation developments derived from the agricultural development plans in the respective basins.

The above is the examination on the following conditions:

i) Surface water only is taken into consideration as the water supply source. This is set as a premise of this study because of the available period for this study.

ii) In case of shortage of the available water, irrigation water demands would be cut considering the degree of importance from the comprehensive viewpoint in comparison of the other sectors.

(2) Irrigation Condition of Srepok River Basin

As explained in Annex 1 of Vietnam water Resources Sector Review, Main Report, May

1996, IWRP, WB, ADB, FAO, UNDP, NGOs, Srepok is one of the few basins in Vietnam where irrigation depends heavily on groundwater, mainly for growing coffee. It mention that all coffee fields (about 43,000 ha) are now (as of 1966) irrigated, half (21,500 ha) by surface water and the rest (21,500 ha) by groundwater from shallow wells.

The following are the important descriptions in the above reference:

i) The potential for an expansion of ground water irrigation is unknown, as the regional groundwater distribution pattern is yet to be studied.

ii) The expansion of groundwater irrigation could affect domestic supplies in rural areas.

iii) Development scenarios based on the government plan assume an expansion in irrigation of 81,000 ha by 2000.

iv) The government intends to bring the entire potential 180,000 ha of undeveloped land under cultivation by 2010.

On the other hand, Agriculture in Vietnam – 61 Provinces and Cities, 2001, MARD, NIAPP shows that the target planted area of coffee as of 2010 is 240,000 ha that is 1.4 times of 175,000 ha as of 1999.

From the above information, the following could be known:

i) From the water balance, irrigable area as of 2020 is 91,000 ha with the surface water. This is 42% of the cultivated land of 219,000 ha (the present's and the future's are the same) consisting of the rain-fed and the irrigated area.

ii) If the groundwater irrigation would be expanded up to 58,000 ha for example that is 1.35 times of the present 43,000 ha, total irrigable area with the surface water and the groundwater as of 2020 would be 149,000 ha. This means that the target irrigation area of 149,000 ha initially planned before the water balance calculation could be realized.

2. LIVESTOCK WATER DEMAND

2.1 Methodology

(1) Unit Water Requirement

With reference to the Guidelines for the Preparation of National Master Water Plans, Water Resources Series No.65, ESCAP, 1989, the unit water requirement (lit/head/day) has been estimated as follows:

(Unit: lit/head/day)

Kind of livestock	Water requirement per head per day
Pig	15
Ox	35
Buffalo	35
Poultry	0.25
Goat	25

(2) Head numbers of various kinds of livestock

With reference to the Agriculture in Vietnam - 61 Provinces and Cities, MARD, NIAPP, 2001, head numbers of various kinds of livestock at present have been estimated.

As for the future numbers, estimation has been made with two separate steps: the first is of the year 2010 and the second is of the year 2020.

Head numbers planned for expansion with specific expectations as of 2010 are found in the Agriculture in Vietnam - 61 Provinces and Cities, MARD, NIAPP, 2001. Forecast for future water demand of 2010 should then be based on such provincial plans.

Estimation for the year 2020 has been made on an assumption that it might keep increase with the same rate as the average annual growth rate planned by each province, which is shown also in the Agriculture in Vietnam - 61 Provinces and Cities, MARD, NIAPP, 2001.

(3) Livestock Water Demand (LWD)

Livestock water demand (LWD) has been calculated as follows:

$$LWD = (UPi \times NPi + UO \times NO + UB \times NB + UPo \times NPo + UG \times NG)/1{,}000$$

where,
- LWD: Livestock water demand (m^3/day)
- UPi: Unit water requirement for pig (lit/head/day)
- NPi: Head number of pig (head)
- UO: Unit water requirement for ox (lit/head/day)
- NO: Head number of ox (head)
- UB: Unit water requirement for buffalo (lit/head/day)
- NB: Head number of buffalo (head)
- UPo: Unit water requirement for poultry (lit/head/day)
- NPo: Head number of poultry (head)
- UG: Unit water requirement for goat (lit/head/day)

NG: Head number of goat (head)

2.2 Forecast of Water Demand for Livestock

With reference to the Agriculture in Vietnam - 61 Provinces and Cities, MARD, NIAAP, 2001, water demands for the present (2001) as well as for the future (2010 and 2020) are estimated as shown in Table F.16 to F.18 respectively, and summarized below:

Present Water Demand for Livestock (2001)

River Basin	Pig (10^3 heads)	Ox (10^3 heads)	Buffalo (10^3 heads)	Poultry (10^3 heads)	Goat (10^3 heads)	Daily Consumption (m^3/day)	Required Intake Discharge (m^3/sec)
01. Bang Giang	332	103	166	2,625	-	15,100	0.18
02. Red	9,082	991	1,473	84,035	-	243,500	2.82
03. Ma	1,494	336	368	11,180	-	49,900	0.58
04. Ca	951	353	292	7,760	-	38,800	0.45
05. Thach Han	186	63	35	1,700	-	6,600	0.08
06. Huong	227	33	35	1,790	-	6,200	0.07
07. Thu Bon	495	214	52	3,910	-	17,700	0.21
08. Tra Khuc	314	174	34	1,935	-	12,500	0.15
09. Kone	221	134	10	1,800	-	8,800	0.10
10. Ba	390	291	17	2,075	-	17,100	0.20
11. Sesan	190	135	14	780	-	8,800	0.10
12. Srepok	299	74	16	2,050	-	8,100	0.09
13. Dong Nai	1,675	313	140	19,980	-	46,000	0.53
14. Cuu Long Delta	2,662	171	41	38,960	-	57,100	0.66

Future Water Demand for Livestock (2010)

River Basin	Pig (10^3 heads)	Ox (10^3 heads)	Buffalo (10^3 heads)	Poultry (10^3 heads)	Goat (10^3 heads)	Daily Consumption (m^3/day)	Required Intake Discharge (m^3/sec)
01. Bang Giang	558	177	355	-	-	27,000	0.31
02. Red	13,663	1,363	1,889	122,957	30	350,200	4.05
03. Ma	2,187	492	482	4,105	-	67,900	0.79
04. Ca	1,248	480	345	14,438	-	51,200	0.59
05. Thach Han	240	85	42	-	-	8,400	0.09
06. Huong	305	49	38	2,261	-	8,200	0.10
07. Thu Bon	533	279	65	4,080	-	21,000	0.24
08. Tra Khuc	436	223	44	90	-	15,900	0.18
09. Kone	361	195	11	3,764	5	13,700	0.16
10. Ba	443	390	21	2,165	-	21,580	0.25
11. Sesan	268	254	27	1,350	-	14,200	0.16
12. Srepok	453	188	23	3,116	-	14,900	0.17
13. Dong Nai	2,657	490	143	38,340	-	71,600	0.83
14. Cuu Long Delta	5,236	270	49	69,417	-	107,000	1.24

Future Water Demand for Livestock (2020)

River Basin	Pig (10^3 heads)	Ox (10^3 heads)	Buffalo (10^3 heads)	Poultry (10^3 heads)	Goat (10^3 heads)	Daily Consumption (m^3/day)	Required Intake Discharge (m^3/sec)
01. Bang Giang	780	307	465	-	-	38,700	0.45
02. Red	20,986	1,997	2,401	241,124	43	530,100	6.14
03. Ma	3,222	719	626	10,979	-	98,100	1.14
04. Ca	1,648	649	409	41,550	-	72,100	0.84
05. Thach Han	402	1,118	50	-	-	11,900	0.14
06. Huong	666	68	42	2,872	-	14,600	0.17
07. Thu Bon	625	356	82	4,780	-	25,900	0.30
08. Tra Khuc	673	302	59	150	-	22,800	0.26
09. Kone	608	298	12	8,135	10	22,300	0.26
10. Ba	615	715	28	4,432	-	36,300	0.42
11. Sesan	385	436	47	2,444	-	23,300	0.27
12. Srepok	747	448	31	7,418	-	29,800	0.35
13. Dong Nai	4,721	821	154	72,960	-	123,200	1.43
14. Cuu Long Delta	10,677	455	47	131,980	-	210,700	2.44

3. AQUACULTURE WATER DEMAND

3.1 Methodology

(1) Unit Fresh Water Requirement

With reference to the Standard on Fishery Industry in Vietnam, Ministry of Fishery, 2000, the unit fresh water requirement (mm/year) has been estimated as follows:

(a) Coastal brackish water shrimp culture

i) Required brackish water for one farming (BWF)

BWF = W1 + W2 + W3 + W4 + W5 = 2.30 m/farming/4months

where, W1: Water filled after farm-bed preparation (0.30 m)
W2: Water for treatment after W1 drained (0.40 m)
W3: Water for cleaning after W2 drained (0.40 m)
W4: Water after nourishment after W3 drained (0.40 m)
W5: Water added to depth 1.20 m for putting larvae (0.80 m)

ii) Required brackish water per year (BWY) (just for reference)

BWY =N x BWF = 6.90 m/year (in case N=3)
= 4.60 m/year (in case N=2)

iii) Required fresh water per year for shrimp culture (FWYS)

FWYS = 0.20 BWF = 0.46 m/ year (for salinity regulation in dry season)

(b) Inland fresh water fish culture

i) Required fresh water for farming per year (FWF)

FWF = W1 + W2 + W3 + W4 = 1.90 m/year

where, W1: Water filled after farm-bed preparation (0.30 m)
W2: Water for treatment after W1 drained (0.40 m)
W3: Water after nourishment after W3 drained (0.40 m)
W4: Water added for putting larvae to depth 1.20 m (0.80 m)

ii) Required fresh water for losses (FWL)

FWL = 1.50 m/year (incl. 1mm/day of percolation)

iii) Required fresh water per year for inland fish culture (FWYI)

FWYI = FWF + FWL = 3.40 m/ year

(2) Aquaculture Pond Area

(a) Present

Present aquaculture pond areas of both the coastal brackish water shrimp culture (AS) and the inland fresh water fish culture (AI) have been taken from the Statistical Data of Vietnam Agriculture, Forestry and Fishery 1975 - 2000, General

Statistical Office - Department of Agriculture, Forestry and Fishery.

Separately for the Cuu Long River Delta, the estimation has been based on the Draft Plan of Transformation in Cuu Long River Delta Aquaculture, undertaken by Institute of Fishery Economics and Planning (IFEP), Ministry of Fishery.

(b) Future

Some provinces have set up their plans for aquaculture development to 2010, and some of the said plans are available in the Agriculture in Vietnam - 61 Provinces and Cities, MARD, NIAPP, 2001. As for other provinces, which do not have specific plan for aquaculture development, it has been assumed that the increase rate in the next ten-year period is 10%, which is equivalent to the annual increase rate of 0.96%.

At present, provinces are rearranging the land use structure. They are transiting paddy fields to shrimp farms or to lands for the other purposes under the Governmental Resolution No. 09 of June 15, 2000. Therefore the assumed growth rate mentioned above and the rates planned by provinces might be changed as occasion demands.

For the case of the Cuu Long River Delta, there was a draft plan for transformation in aquaculture. It includes proposed provincial plans and plans for the respective provinces prepared by the Institute of Fishery Economics and Planning (IFEP). In realizing the Governmental Resolution No. 09 of June 15, 2000 regarding the transformation in aquaculture, the final plan of aquaculture development would come to 2010, which contains the area expansion plan for both the coastal brackish water shrimp culture and the inland fresh water fish culture as well. Our estimation for the Cuu Long River Delta is based on that.

Further, forecast of fresh water demand for aquaculture of 2020 has been estimated based on the respective average growth rates by river basins, which have been tentatively assumed to be one fourth (1/4) of those in the 2000 - 2010 period.

(3) Aquaculture Water Demand (AWD)

Aquaculture fresh water demand (AWD) for both the coastal brackish water shrimp culture and the inland fresh water fish culture have been calculated as follows:

$$AWD = FWYS \times 10{,}000AS + FWYI \times 10{,}000AI$$

where,
- AWD: Aquaculture water demand (m^3/year)
- FWYS: Required freshwater for shrimp culture (m/year)
- AS: Shrimp culture pond area (ha)
- FWYI: Required freshwater for fish culture (m/year)

AI: Inland fish culture pond area (ha)

3.2 Forecast of Aquaculture Water Demand

(1) Present Water Demand for Aquaculture

With use of the unit water requirement, which is expressed in the water depth (m/year), and the estimated aquaculture pond area (ha), the present and future water demands have been estimated as shown in Table F.19 to F.21 respectively and summarized as follows:

Present Water Demand for Aquaculture (2001)

River Basin	Coastal Shrimp Culture		Inland Fish Culture		Total	
	Pond Area (ha)	Fresh Water Demand (10^3 m^3)	Pond Area (ha)	Fresh Water Demand (10^3 m^3)	Fresh Water Demand (10^3 m^3)	Average Intake Discharge (m^3/sec)
01. Bang Giang	-	-	710	24,115	24,115	0.8
02. Red	9,680	44,519	80,640	2,741,615	2,786,134	88.3
03. Ma	4,780	21,988	11,230	381,718	403,706	12.8
04. Ca	1,760	8,096	8,280	281,384	289,480	9.2
05. Thach Han	190	874	520	17,680	18,554	0.6
06. Huong	1,010	4,646	920	31,280	35,926	1.1
07. Thu Bon	1,190	5,451	3,430	116,654	122,105	3.9
08. Tra Khuc	380	1,725	70	2,193	3,918	0.1
09. Kone	940	4,301	690	23,435	27,736	0.9
10. Ba	840	3,844	700	23,860	27,704	0.9
11. Se Sang	-	-	360	12,291	12,291	0.4
12. Srepok	-	-	1,840	62,475	62,475	2.0
13. Dong Nai	6,590	30,296	26,990	917,711	948,007	30.1
14. Cuu Long Delta	392,200	1,804,122	119,560	4,064,972	5,869,094	186.1

Future Water Demand for Aquaculture (2010)

River Basin	Coastal Shrimp Culture		Inland Fish Culture		Total	
	Pond Area (ha)	Fresh Water Demand (10^3 m^3)	Pond Area (ha)	Fresh Water Demand (10^3 m^3)	Fresh Water Demand (10^3 m^3)	Average Intake Discharge (m^3/sec)
01. Bang Giang	-	-	910	31,035	31,035	1.0
02. Red	14,830	68,195	119,990	4,079,810	4,148,005	131.5
03. Ma	5,020	23,097	13,810	469,587	492,684	15.6
04. Ca	2,280	10,495	11,790	401,010	411,505	13.0
05. Thach Han	270	1,228	730	24,888	26,116	0.8
06. Huong	3,290	15,147	2,730	92,643	107,790	3.4
07. Thu Bon	1,230	5,637	3,560	120,866	126,503	4.0
08. Tra Khuc	410	1,898	70	2,412	4,310	0.1
09. Kone	1,030	4,731	760	25,779	30,510	1.0
10. Ba	1,370	6,321	790	37,575	33,896	1.1
11. Se Sang	-	-	400	13,525	13,525	0.4
12. Srepok	-	-	2,020	68,731	68,731	2.2
13. Dong Nai	7,790	35,833	31,050	1,055,824	1,091,657	34.6
14. Cuu Long Delta	527,930	2,428,439	207,260	7,046,687	9,475,126	300.5

Future Water Demand for Aquaculture (2020)

River Basin	Coastal Shrimp Culture		Inland Fish Culture		Total	
	Pond Area (ha)	Fresh Water Demand (10^3 m^3)	Pond Area (ha)	Fresh Water Demand (10^3 m^3)	Fresh Water Demand (10^3 m^3)	Average Intake Discharge (m^3/sec)
01. Bang Giang	-	-	960	32,497	32,497	1.0
02. Red	16,100	74,061	130,300	4,430,053	4,504,114	142.8
03. Ma	5,510	25,335	14,360	488,280	513,615	16.3
04. Ca	2,430	11,163	12,540	426,418	437,581	13.9
05. Thach Han	290	1,342	800	27,143	28,485	0.9
06. Huong	4,510	20,762	3,690	125,545	146,307	4.6
07. Thu Bon	1,260	5,776	3,640	123,863	129,639	4.1
08. Tra Khuc	450	2,087	70	2,472	4,559	0.1
09. Kone	1,050	4,847	780	26,418	31,265	1.0
10. Ba	1,480	6,815	810	27,692	34,507	1.1
11. Se Sang	-	-	410	13,903	13,903	0.4
12. Srepok	-	-	2,090	70,907	70,907	2.2
13. Dong Nai	8,570	39,412	33,530	1,140,120	1,179,532	37.4
14. Cuu Long Delta	677,520	3,116,603	265,980	9,043,292	12,159,895	385.6

4 WATER DEMAND FOR AGRICULTURE

Agricultural Water Demand (AWD) for irrigation, livestock aquaculture
-Average Rainfall Year- (m^3/sec)

River Basin		Present (2001)	Future (2010)	Future (2020)
01. Bang Giang	Total	9.5	13.1	14.5
	Irrigation	8.5	11.8	13.0
	Livestock	0.2	0.3	0.5
	Aquaculture	0.8	1.0	1.0
02. Red	Total	510.1	595.5	602.8
	Irrigation	419.0	459.9	453.9
	Livestock	2.8	4.1	6.1
	Aquaculture	88.3	131.5	142.8
03. Ma	Total	55.4	69.0	72.8
	Irrigation	42.0	52.6	55.4
	Livestock	0.6	0.8	1.1
	Aquaculture	12.8	15.6	16.3
04. Ca	Total	44.9	55.9	62.9
	Irrigation	35.2	42.3	48.2
	Livestock	0.5	0.6	0.8
	Aquaculture	9.2	13.0	13.9
05. Thach Han	Total	3.0	5.3	5.9
	Irrigation	2.3	4.4	4.9
	Livestock	0.1	0.1	0.1
	Aquaculture	0.6	0.8	0.9
06. Huong	Total	11.1	13.1	15.5
	Irrigation	9.9	9.6	10.7
	Livestock	0.1	0.1	0.2
	Aquaculture	1.1	3.4	4.6
07. Thu Bon	Total	15.5	24.3	24.3
	Irrigation	11.4	20.1	19.9
	Livestock	0.2	0.2	0.3
	Aquaculture	3.9	4.0	4.1
08. Tra Khuc	Total	13.1	13.4	13.5
	Irrigation	12.8	13.1	13.1
	Livestock	0.2	0.2	0.3
	Aquaculture	0.1	0.1	0.1
09. Kone	Total	22.5	27.8	31.7
	Irrigation	21.5	26.6	30.4
	Livestock	0.1	0.2	0.3
	Aquaculture	0.9	1.0	1.0
10. Ba	Total	27.5	56.8	70.4
	Irrigation	26.4	55.4	68.9
	Livestock	0.2	0.3	0.4
	Aquaculture	0.9	1.1	1.1
11. Sesan	Total	6.3	10.2	13.4
	Irrigation	5.8	9.6	12.6
	Livestock	0.1	0.2	0.3
	Aquaculture	0.4	0.4	0.4
12. Srepok	Total	15.1	15.3	33.1
	Irrigation	13.0	12.9	30.5
	Livestock	0.1	0.2	0.4
	Aquaculture	2.0	2.2	2.2
13. Dong Nai	Total	109.1	137.1	158.0
	Irrigation	78.5	101.7	119.2
	Livestock	0.5	0.8	1.4
	Aquaculture	30.1	34.6	37.4
14. Cuu Long Delta	Total	1,110.7	1,325.5	1,463.9
	Irrigation	923.9	1,023.8	1,075.9
	Livestock	0.7	1.2	2.4
	Aquaculture	186.1	300.5	385.6

Table F.1 Calculation Sheet of Potential Evapotranspiration (ETo)

Kone Basin (Quy Nhon: 14°North, 10 m in Altitude)

No.	Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1	Tmean (°C)*	23.0	24.0	26.0	27.0	28.8	29.1	29.4	29.4	28.0	26.4	24.7	24.0
2	RHmean (%)*	92.5	93.0	93.5	93.0	92.0	88.0	83.0	82.5	88.5	93.0	95.0	95.0
3	ea (mbar)	28.1	29.8	33.6	35.7	39.6	40.3	41.0	41.0	37.8	34.4	31.1	29.8
4	ed (mbar)	26.0	27.7	31.4	33.2	36.5	35.5	34.0	33.8	33.5	32.0	29.6	28.3
5	(ea-ed) (mbar)	2.1	2.1	2.2	2.5	3.2	4.8	7.0	7.2	4.3	2.4	1.6	1.5
6	Wind, Vw (m/s)*	2.5	3.0	3.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.5	3.0
7	U (km/day)	216.0	259.2	302.4	345.6	345.6	345.6	345.6	345.6	345.6	345.6	302.4	259.2
8	f(u)	0.85	0.97	1.09	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.09	0.97
9	(1-W) of wind & humidity	0.28	0.27	0.25	0.24	0.23	0.23	0.23	0.23	0.23	0.25	0.27	0.27
10	Sunshine, n (hr)*	5.8	6.5	7.3	8.3	9.2	7.3	8.8	7.8	7.0	6.3	4.7	4.5
11	W of radiation	0.72	0.73	0.75	0.76	0.77	0.78	0.78	0.78	0.77	0.75	0.73	0.73
12	Ra (mm/day)	12.4	13.6	14.9	15.7	15.8	15.7	15.7	15.7	15.1	14.1	12.8	12.0
13	N (hr)	11.3	11.6	12.0	12.5	12.8	13.0	12.9	12.6	12.2	11.8	11.4	11.2
14	n/N	0.52	0.56	0.61	0.67	0.72	0.56	0.68	0.62	0.57	0.54	0.41	0.40
15	Rs (mm/day)	6.3	7.2	8.3	9.2	9.6	8.4	9.3	8.8	8.1	7.3	5.8	5.4
16	Rns (mm/day)	4.7	5.4	6.2	6.9	7.2	6.3	7.0	6.6	6.1	5.5	4.4	4.1
17	f(Tmean)	15.2	15.4	15.9	16.1	16.4	16.5	16.5	16.5	16.3	15.9	15.5	15.4
18	f(ed)	0.12	0.11	0.09	0.09	0.07	0.08	0.08	0.08	0.09	0.09	0.10	0.11
19	f(n/N)	0.56	0.60	0.65	0.70	0.74	0.61	0.72	0.66	0.62	0.58	0.47	0.46
20	Rnl (mm/day)	1.0	1.0	1.0	1.0	0.9	0.8	1.0	0.9	0.9	0.8	0.7	0.8
21	Rn (mm/day)	3.7	4.4	5.2	5.9	6.3	5.5	6.0	5.7	5.2	4.6	3.6	3.3
22	c	0.94	0.95	0.96	0.98	0.99	0.94	0.98	0.96	0.94	0.91	0.88	0.90
23	ETo (mm/day)	3.01	3.57	4.35	5.10	5.66	5.25	6.40	6.11	4.93	3.82	2.75	2.51
24	ETo (mm/day) (c=1)	3.19	3.76	4.53	5.20	5.73	5.56	6.53	6.35	5.22	4.20	3.11	2.80
25	ATLAS's ETo(mm/day)	3.39	3.93	4.55	5.30	5.68	6.07	6.16	5.94	5.07	4.00	3.43	3.10

Note. Data in Vietnam Hydrometeological ATLAS, 1994 are used.

Table F.2 Potential Evapotranspiration (ETo)

River Basin		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total (mm/year)
01. Bang Giang	(mm/month)	67	65	81	95	136	120	136	120	118	100	82	68	1,188
Lang Son	%	*5.6*	*5.5*	*6.8*	*8*	*11.5*	*10.1*	*11.5*	*10.1*	*9.9*	*8.4*	*6.9*	*5.7*	*100*
02. Red	(mm/month)	63	66	75	92	147	140	146	129	125	111	85	70	1,249
Hanoi	%	*5*	*5.3*	*6*	*7.4*	*11.8*	*11.2*	*11.7*	*10.3*	*10*	*8.9*	*6.8*	*5.6*	*100*
03. Ma	(mm/month)	55	48	60	88	137	136	151	122	109	101	71	62	1,140
Thanh Hoa	%	*4.8*	*4.2*	*5.3*	*7.7*	*12*	*11.9*	*13.3*	*10.7*	*9.6*	*8.9*	*6.2*	*5.4*	*100*
04. Ca	(mm/month)	51	50	69	97	148	151	168	136	110	89	61	53	1,183
Vinh	%	*4.3*	*4.2*	*5.8*	*8.2*	*12.5*	*12.8*	*14.2*	*11.5*	*9.3*	*7.5*	*5.2*	*4.5*	*100*
05. Thach Han	(mm/month)	68	68	82	116	150	176	189	163	116	96	75	61	1,360
Hue (nearest in ATLAS)	%	*5*	*5*	*6*	*8.5*	*11*	*13*	*14*	*12*	*8.5*	*7*	*5.5*	*4.5*	*100*
06. Huong	(mm/month)	68	68	82	116	150	176	189	163	116	96	75	61	1,360
Hue	%	*5*	*5*	*6*	*8.5*	*11*	*13*	*14*	*12*	*8.5*	*7*	*5.5*	*4.5*	*100*
07. Thu Bon	(mm/month)	62	67	93	104	125	128	139	120	101	82	71	64	1,156
Da Nang	%	*5.4*	*5.8*	*8*	*9*	*10.8*	*11.2*	*12*	*10.4*	*8.7*	*7.1*	*6.1*	*5.5*	*100*
08. Tra Khuc	(mm/month)	62	67	93	104	125	128	139	120	101	82	71	64	1,156
Da Nang (nearest in ATLAS)	%	*5.4*	*5.8*	*8*	*9*	*10.8*	*11.2*	*12*	*10.4*	*8.7*	*7.1*	*6.1*	*5.5*	*100*
09. Kone	(mm/month)	105	110	141	159	176	182	191	184	152	124	103	96	1,723
Quy Nhon	%	*6.1*	*6.4*	*8.2*	*9.2*	*10.2*	*10.5*	*11.1*	*10.7*	*8.8*	*7.2*	*6*	*5.6*	*100*
10. Ba	(mm/month)	90	97	134	151	181	188	201	174	146	119	102	92	1,675
Nha Trang	%	*5.4*	*5.8*	*8*	*9*	*10.8*	*11.2*	*12*	*10.4*	*8.7*	*7.1*	*6.1*	*5.5*	*100*
11. Sesan	(mm/month)	100	109	138	127	116	104	91	85	85	97	110	87	1,249
Kon Tum	%	*8*	*8.7*	*11*	*10.2*	*9.3*	*8.3*	*7.3*	*6.8*	*6.8*	*7.8*	*8.8*	*7*	*100*
12. Srepok	(mm/month)	121	156	183	167	144	122	116	122	102	105	102	107	1,547
Buon Ma Thuot	%	*7.8*	*10.1*	*11.8*	*10.8*	*9.3*	*7.9*	*7.5*	*7.9*	*6.6*	*6.8*	*6.6*	*6.9*	*100*
13. Dong Nai	(mm/month)	149	174	217	210	177	138	143	140	132	133	129	136	1,878
Bien Hoa (from Dong Nai MP)	%	*7.9*	*9.3*	*11.6*	*11.2*	*9.4*	*7.3*	*7.6*	*7.5*	*7.0*	*7.1*	*6.9*	*7.2*	*100*
14. Cuu Long Delta	(mm/month)	113	121	161	166	128	113	124	124	118	118	110	113	1,509
Can Tho	%	*7.5*	*8*	*10.7*	*11*	*8.5*	*7.5*	*8.2*	*8.2*	*7.8*	*7.8*	*7.3*	*7.5*	*100*

Note. ETo data in Vietnam Hydrometeological ATLAS, 1994 are used.

Table F.3 Monthly Gross Unit Irrigation Requirement, Kone, 2001

(Unit : l/sec/ha)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1976	0.90	1.04	1.00	0.84	1.41	1.54	0.76	0.85	0.70	0.24	0.25	0.65	0.85
1977	1.03	1.25	1.01	1.01	1.78	1.59	0.70	1.40	0.48	0.32	0.23	0.91	0.98
1978	0.46	1.14	1.05	0.92	1.00	1.31	0.54	1.08	0.68	0.13	0.29	0.90	0.79
1979	1.23	1.25	1.05	1.00	1.47	1.18	0.82	1.41	0.78	0.22	0.30	0.70	0.95
1980	1.20	1.25	1.05	0.97	1.01	1.01	0.73	1.32	0.87	0.03	0.26	0.92	0.88
1981	1.23	1.25	1.05	0.83	1.71	1.05	0.69	1.67	0.82	0.00	0.14	0.30	0.89
1982	1.19	1.25	1.04	0.94	1.68	1.29	0.79	1.54	0.77	0.38	0.31	0.85	1.00
1983	1.05	1.25	1.04	0.99	1.56	1.08	0.74	0.94	0.76	0.04	0.25	0.57	0.86
1984	1.00	1.25	1.05	0.89	1.17	0.73	0.73	1.73	1.10	0.18	0.20	0.49	0.88
1985	1.07	1.21	1.05	0.79	1.24	1.28	0.70	1.65	0.65	0.24	0.18	0.37	0.87
1986	1.18	1.00	1.04	1.01	1.18	1.58	0.80	1.47	1.09	0.10	0.37	0.13	0.91
1987	1.21	1.16	1.05	1.01	1.45	1.44	0.65	1.39	0.98	0.58	0.13	0.74	0.98
1988	1.12	0.88	1.03	0.98	1.79	1.28	0.56	1.70	0.75	0.03	0.28	0.67	0.92
1989	0.94	1.23	0.73	1.00	1.28	1.16	0.67	0.80	1.52	0.45	0.56	1.11	0.95
1990	1.18	1.25	1.01	0.53	0.94	0.70	0.80	1.27	0.90	0.00	0.27	0.40	0.77
1991	0.90	0.91	0.90	0.79	1.64	1.18	0.71	1.62	0.73	0.19	0.35	0.61	0.88
1992	1.23	1.25	1.05	1.01	1.18	1.42	0.81	1.26	1.04	0.03	0.32	1.15	0.98
1993	1.23	1.25	1.05	0.91	1.17	1.74	0.72	1.60	0.68	0.10	0.28	0.19	0.91
1994	1.23	1.04	1.00	1.01	1.51	1.34	0.83	1.28	0.73	0.30	0.43	0.32	0.92
1995	1.23	1.04	1.04	0.92	1.09	1.53	0.81	1.29	0.85	0.09	0.29	0.53	0.89
1996	1.23	0.59	1.05	0.56	1.73	1.56	0.75	0.76	0.41	0.00	0.26	1.15	0.84
1997	1.23	1.25	1.05	0.90	1.29	1.35	0.63	1.66	0.65	0.31	0.28	0.57	0.93
1998	0.96	1.25	1.01	0.90	1.20	1.66	0.71	1.17	0.73	0.18	0.13	0.14	0.84
1999	0.69	1.01	1.03	0.66	1.26	1.43	0.79	1.69	1.08	0.06	0.20	0.13	0.83
2000	0.66	1.25	1.05	0.91	0.84	1.11	0.62	0.97	1.39	0.12	0.28	0.58	0.82
Average	1.06	1.14	1.02	0.89	1.34	1.30	0.72	1.34	0.84	0.17	0.27	0.60	0.89

Table F.4 Monthly Gross Unit Irrigation Requirement, Kone, 2010

(Unit : l/sec/ha)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1976	0.78	0.90	0.76	0.63	1.08	1.29	0.82	0.79	0.59	0.21	0.21	0.55	0.72
1977	0.90	1.11	0.77	0.76	1.41	1.34	0.76	1.28	0.40	0.27	0.19	0.78	0.83
1978	0.39	1.01	0.80	0.69	0.74	1.08	0.60	1.00	0.58	0.11	0.25	0.77	0.67
1979	1.08	1.11	0.80	0.76	1.12	0.95	0.88	1.29	0.67	0.18	0.25	0.60	0.81
1980	1.06	1.10	0.80	0.73	0.75	0.80	0.78	1.20	0.75	0.02	0.22	0.79	0.75
1981	1.08	1.11	0.80	0.62	1.35	0.83	0.75	1.52	0.71	0.00	0.12	0.25	0.76
1982	1.05	1.11	0.80	0.71	1.32	1.06	0.85	1.40	0.66	0.32	0.26	0.73	0.86
1983	0.91	1.11	0.79	0.74	1.21	0.87	0.80	0.87	0.66	0.04	0.21	0.48	0.73
1984	0.87	1.11	0.80	0.66	0.86	0.54	0.79	1.56	0.96	0.15	0.17	0.41	0.74
1985	0.94	1.06	0.80	0.59	0.93	1.05	0.76	1.50	0.55	0.20	0.15	0.31	0.74
1986	1.04	0.87	0.80	0.76	0.87	1.32	0.86	1.34	0.94	0.08	0.31	0.10	0.78
1987	1.06	1.02	0.80	0.76	1.10	1.20	0.72	1.27	0.85	0.50	0.11	0.64	0.84
1988	0.98	0.76	0.78	0.74	1.42	1.05	0.63	1.55	0.65	0.02	0.24	0.57	0.78
1989	0.82	1.09	0.54	0.76	0.95	0.93	0.74	0.74	1.32	0.38	0.50	0.97	0.81
1990	1.03	1.11	0.77	0.39	0.69	0.52	0.86	1.16	0.77	0.00	0.23	0.34	0.66
1991	0.78	0.79	0.68	0.58	1.28	0.95	0.77	1.47	0.62	0.16	0.29	0.52	0.74
1992	1.08	1.11	0.80	0.76	0.87	1.18	0.87	1.15	0.90	0.02	0.27	1.01	0.83
1993	1.08	1.11	0.80	0.68	0.86	1.46	0.78	1.46	0.58	0.08	0.24	0.16	0.77
1994	1.08	0.90	0.76	0.76	1.16	1.11	0.89	1.17	0.62	0.25	0.37	0.27	0.78
1995	1.08	0.90	0.79	0.69	0.81	1.28	0.87	1.18	0.73	0.08	0.24	0.45	0.76
1996	1.08	0.50	0.80	0.42	1.37	1.31	0.81	0.70	0.34	0.00	0.22	1.01	0.71
1997	1.08	1.11	0.80	0.67	0.97	1.12	0.70	1.51	0.55	0.26	0.24	0.48	0.79
1998	0.83	1.11	0.77	0.67	0.89	1.40	0.78	1.07	0.63	0.15	0.11	0.12	0.71
1999	0.59	0.88	0.78	0.48	0.94	1.18	0.85	1.53	0.93	0.05	0.16	0.10	0.71
2000	0.56	1.11	0.80	0.69	0.61	0.89	0.69	0.90	1.21	0.10	0.24	0.49	0.69
Average	0.93	1.01	0.78	0.67	1.02	1.07	0.78	1.22	0.73	0.15	0.23	0.52	0.76

Table F.5 Monthly Gross Unit Irrigation Requirement, Kone, 2020

(Unit : l/sec/ha)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1976	0.68	0.80	0.54	0.44	0.78	1.07	0.89	0.76	0.52	0.18	0.18	0.48	0.61
1977	0.80	0.99	0.55	0.54	1.10	1.11	0.83	1.20	0.35	0.24	0.17	0.70	0.71
1978	0.34	0.90	0.57	0.49	0.51	0.87	0.67	0.94	0.51	0.09	0.21	0.68	0.57
1979	0.96	0.99	0.57	0.54	0.83	0.75	0.95	1.21	0.59	0.16	0.22	0.52	0.69
1980	0.95	0.98	0.57	0.52	0.52	0.62	0.86	1.13	0.67	0.02	0.19	0.71	0.64
1981	0.96	0.99	0.57	0.43	1.04	0.65	0.82	1.42	0.62	0.00	0.10	0.21	0.65
1982	0.94	0.99	0.56	0.50	1.01	0.86	0.92	1.32	0.58	0.28	0.22	0.64	0.74
1983	0.81	0.99	0.56	0.53	0.90	0.68	0.87	0.83	0.58	0.03	0.18	0.42	0.62
1984	0.77	0.99	0.57	0.47	0.60	0.39	0.87	1.47	0.86	0.13	0.15	0.36	0.63
1985	0.83	0.95	0.57	0.40	0.65	0.85	0.83	1.41	0.48	0.17	0.13	0.27	0.63
1986	0.93	0.77	0.56	0.54	0.61	1.10	0.93	1.26	0.84	0.07	0.27	0.09	0.66
1987	0.95	0.91	0.57	0.54	0.81	0.98	0.78	1.20	0.75	0.44	0.10	0.56	0.72
1988	0.88	0.67	0.55	0.53	1.10	0.85	0.69	1.45	0.57	0.02	0.21	0.50	0.67
1989	0.73	0.97	0.38	0.54	0.67	0.74	0.80	0.71	1.19	0.33	0.45	0.87	0.70
1990	0.92	0.99	0.54	0.27	0.48	0.36	0.93	1.09	0.69	0.00	0.20	0.29	0.56
1991	0.68	0.70	0.47	0.40	0.97	0.76	0.83	1.38	0.55	0.14	0.25	0.45	0.63
1992	0.96	0.99	0.57	0.54	0.61	0.97	0.94	1.09	0.81	0.02	0.23	0.90	0.72
1993	0.96	0.99	0.57	0.49	0.60	1.24	0.85	1.37	0.51	0.07	0.21	0.14	0.67
1994	0.96	0.80	0.54	0.54	0.86	0.90	0.96	1.10	0.55	0.22	0.33	0.24	0.67
1995	0.96	0.80	0.56	0.49	0.56	1.06	0.94	1.11	0.65	0.07	0.21	0.39	0.65
1996	0.96	0.44	0.57	0.29	1.05	1.09	0.88	0.67	0.30	0.00	0.19	0.90	0.61
1997	0.96	0.99	0.57	0.48	0.68	0.91	0.77	1.41	0.48	0.22	0.20	0.42	0.67
1998	0.74	0.99	0.54	0.48	0.62	1.18	0.85	1.01	0.55	0.13	0.10	0.10	0.61
1999	0.51	0.78	0.55	0.34	0.66	0.97	0.92	1.44	0.84	0.05	0.14	0.09	0.61
2000	0.48	0.99	0.57	0.49	0.43	0.70	0.76	0.85	1.09	0.09	0.21	0.43	0.59
Average	0.83	0.89	0.55	0.47	0.75	0.87	0.85	1.15	0.65	0.13	0.20	0.45	0.65

Table F.6 Irrigation Water Requirement, Kone, 2001, 1/4 Drought Year

Kone River Basin **(using ETo data in Quy Nhon, Rainfall data in Phu Cat, Present Cropping Pattern (2001)**

No.	Year	No.	Crop	Cropping Area (ha)	Area Ratio	Jan. 1	Jan. 2	Jan. 3	Feb. 1	Feb. 2	Feb. 3	Mar. 1	Mar. 2	Mar. 3	Apr. 1	Apr. 2	Apr. 3	May 1	May 2	May 3	Jun. 1	Jun. 2	Jun. 3	Jul. 1	Jul. 2	Jul. 3	Aug. 1	Aug. 2	Aug. 3	Sep. 1	Sep. 2	Sep. 3	Oct. 1	Oct. 2	Oct. 3	Nov. 1	Nov. 2	Nov. 3	Dec. 1	Dec. 2	Dec. 3	Total (mm/period)	Gross Requirement Depth (mm/year)	Gross Requirement Volume (m3/year/ha)
						Cropping Period																																						
			Potential Evapotranspiration (ETo)	mm/month			105			110			141			159			176			182			191			184			152			124			103			96		1,723		
			Potential Evapotranspiration (ETo)	mm/10-day		35	35	35	37	37	36	47	47	47	53	53	53	58	58	60	61	61	60	63	63	65	61	61	62	51	51	50	41	41	42	34	34	35	32	32	32	1,723		
			Effective Rainfall (Pe)			5	5	7	17	17	20	2	2	4	1	1	3	0	0	1	23	23	24	43	43	43	3	3	3	47	47	47	69	69	70	53	53	52	26	26	25	877		
A	**Winter - Spring Crops**																																											
	1988	**1.**	**Paddy**	**24,000**	**0.96**																																							
		a	**Land Preparation (60 mm)**																																	**20.0**	**20.0**		**20.0**			60		
			Area (A %)																																	*33*	*67*							
		b	Evaporation (ETo*1.1*A%)																																	12.3	25.8					38		
		c	Percolation (2mm/day*A%)																																	6.6	13.4					20		
		d	Total Land Preparation Req. (a+b+c)																																	38.9	59.2	20.0				118		
			Crop Coefficient (kc)			*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																										*1.05*	*1.11*	*1.20*			
		e	**Crop Water Req. (CWR)**			**45.5**	**46.9**	**47.3**	**48.5**	**44.4**	**36.7**	**0.0**																										**33.6**	**35.5**	**38.4**	**377**		
		f	Percolation (2mm/day)			20.0	20.0	22.0	20.0	20.0	16.0	0.0																										20.0	20.0	22.0	180		
		g	Consumptive Use (CUW) (d+e+f)			65.5	66.9	69.3	68.5	64.4	52.7	0.0																								38.9	59.2	73.6	55.5	60.4	675		
		h	Effective Rainfall (Pe*A% or Pe)			5.0	5.0	7.0	17.0	17.0	20.0	2.0																								17.5	34.8	26.0	26.0	25.0	202		
		i	Net Irri. Req. (NIR)	mm/10-day		60.5	61.9	62.3	51.5	47.4	32.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.5	24.4	47.6	29.5	35.4	475	791	**7,909**
		2.	**Upland Crops**	**500**	**0.02**																																							
			Crop Coefficient (kc) (Tomato)			*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*																							*0.35*	*0.38*	*0.45*			
			Crop Water Req. (CWR)			**20.3**	**25.9**	**30.8**	**37.0**	**40.0**	**38.9**	**49.4**	**44.7**	**30.1**	**13.3**																							**11.2**	**12.2**	**14.4**	**368**		
			Effective rainfall (Pe)			5.0	5.0	7.0	17.0	17.0	20.0	2.0	2.0	4.0	1.0																							26.0	26.0	25.0	157		
			Net Irri. Req. (NIR)	mm/10-day		15.3	20.9	23.8	20.0	23.0	18.9	47.4	42.7	26.1	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	250	417	**4,170**
B	**Summer - Autumn Crops**																																											
	1988	**1.**	**Paddy**	**24,000**	**0.96**																																							
		a	**Land Preparation (150 mm)**										**50.0**	**50.0**	**50.0**																										150		
			Area (A %)										*33*	*67*																													
		b	Evaporation (ETo*1.1*A%)										17.1	34.6																													
		c	Percolation (2mm/day*A%)										6.6	14.7																													
		d	Total Land Preparation Req. (a+b+c)										73.7	99.4	50.0																												
			Crop Coefficient (kc)												*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																			
		e	**Crop Water Req. (CWR)**												**55.7**	**58.8**	**63.6**	**75.4**	**77.7**	**81.0**	**79.9**	**73.2**	**61.2**	**0.0**																		**627**		
		f	Percolation (2mm/day)												20.0	20.0	20.0	20.0	20.0	22.0	20.0	20.0	20.0	0.0																		182		
		g	Consumptive Use (CUW) (d+e+f)										73.7	99.4	85.7	78.8	83.6	95.4	97.7	103.0	99.9	93.2	81.2	0.0																		1032		
		h	Effective Rainfall (Pe*A% or Pe)										0.7	2.7	1.0	1.0	3.0	0.0	0.0	1.0	23.0	23.0	24.0	43.0																		122		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.0	96.7	84.7	77.8	80.6	95.4	97.7	102.0	76.9	70.2	57.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	828	1,379	**13,793**
		2.	**Upland Crops**	**500**	**0.02**																																							
			Crop Coefficient (kc) (Tomato)														*0.35*	*0.38*	*0.45*	*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*														
			Crop Water Req. (CWR)														**18.6**	**22.0**	**26.1**	**34.8**	**45.1**	**53.7**	**60.0**	**68.0**	**68.0**	**68.3**	**58.0**	**39.0**	**15.5**													**577**		
			Effective rainfall (Pe)														3.0	0.0	0.0	1.0	23.0	23.0	24.0	16.0	16.0	15.0	17.0	17.0	19.0													174		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.6	22.0	26.1	33.8	22.1	30.7	36.0	52.0	52.0	53.3	41.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	407	678	**6,777**
C	**Rainy Season Crops**																																											
	1988	**1.**	**Paddy**	**24,000**	**0.96**																																							
		a	**Land Preparation (60 mm)**																						**20.0**	**20.0**	20.00														60		
			Area (A %)																						*33*	**67.00**																	
		b	Evaporation (ETo*1.1*A%)																						22.9	47.9																	
		c	Percolation (2mm/day*A%)																						6.6	14.7																	
		d	Total Land Preparation Req. (a+b+c)																						49.5	82.6	20.00																
			Crop Coefficient (kc)																								*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*							
		e	**Crop Water Req. (CWR)**																								**64.1**	**67.7**	**74.4**	**66.3**	**68.3**	**67.5**	**53.7**	**49.2**	**42.8**	**0.0**						**554**		
		f	Percolation (2mm/day)																								20.0	20.0	22.0	20.0	20.0	20.0	20.0	20.0	22.0	0.0						184		
		g	Consumptive Use (CUW) (d+e+f)																						49.5	82.6	104.1	87.7	96.4	86.3	88.3	87.5	73.7	69.2	64.8	0.0						890		
		h	Effective Rainfall (Pe*A% or Pe)																						14.2	28.8	3.0	3.0	3.0	47.0	47.0	47.0	69.0	69.0	70.0	53.0						454		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.3	53.8	101.1	84.7	93.4	39.3	41.3	40.5	4.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	494	824	**8,239**
		2.	**Upland Crops**	**0**	**0.00**																																							
			Crop Coefficient (kc) (Tomato)																																									
			Crop Water Req. (CWR)																																							**0**		
			Effective rainfall (Pe)																																							0		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	-
D	**Year Round Crop**																																											
	1988	**1.**	**Upland Crops**	**e4+g4+h4**	**500**	**0.02**																																						
			Crop Coefficient (kc) (Sugar Cane)			*0.97*	*0.92*	*0.85*	*0.78*	*0.71*	*0.60*	*0.55*	*0.50*	*0.50*	*0.50*	*0.50*	*0.00*	*0.55*	*0.57*	*0.65*	*0.75*	*0.85*	*0.95*	*1.00*	*1.05*	*1.08*	*1.11*	*1.14*	*1.15*	*1.15*	*1.16*	*1.15*	*1.15*	*1.14*	*1.13*	*1.12*	*1.10*	*1.08*	*1.06*	*1.03*	*1.00*			
			Crop Water Req. (CWR)			**34.0**	**32.2**	**29.8**	**28.9**	**26.3**	**21.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.9**	**33.1**	**39.0**	**45.8**	**51.9**	**57.0**	**63.0**	**66.2**	**70.2**	**67.7**	**69.5**	**71.3**	**58.7**	**59.2**	**57.5**	**47.2**	**46.7**	**47.5**	**38.1**	**37.4**	**37.8**	**33.9**	**33.0**	**32.0**	**1368**		
			Effective rainfall (Pe)			5.0	5.0	7.0	17.0	17.0	20.0	2.0	2.0	4.0	1.0	1.0	3.0	0.0	0.0	1.0	23.0	23.0	24.0	43.0	43.0	43.0	3.0	3.0	3.0	47.0	47.0	47.0	69.0	69.0	70.0	53.0	53.0	52.0	26.0	26.0	25.0	877		
			Net Irri. Req. (NIR)	mm/10-day		29.0	27.2	22.8	11.9	9.3	1.6	0.0	0.0	0.0	0.0	0.0	0.0	31.9	33.1	38.0	22.8	28.9	33.0	20.0	23.2	27.2	64.7	66.5	68.3	11.7	12.2	10.5	0.0	0.0	0.0	0.0	0.0	0.0	7.9	7.0	7.0	615	1,025	**10,255**
					73,500	2.94																																						
			Weighted Ave. NIR	Total	**25,000**	**1.00**	59.0	60.4	60.7	50.1	46.2	31.8	1.0	70.9	93.4	81.6	74.7	77.7	92.7	95.0	99.4	74.7	68.6	56.3	1.4	35.4	53.3	99.1	83.1	91.0	38.0	39.9	39.1	4.5	0.2	0.0	0.0	20.6	23.4	45.9	28.5	34.1		**2,917**	**29,167**
			Gross Irri. Req. GIR	mm/10-day	Irri. Efficiency **0.60**	98.3	100.7	101.2	83.4	76.9	53.0	1.6	118.2	155.6	136.0	124.5	129.5	154.4	158.3	165.6	124.6	114.3	93.8	2.4	59.0	88.8	165.2	138.5	151.7	63.3	66.6	65.2	7.5	0.3	0.0	0.0	34.3	39.0	76.4	47.5	56.9			
			Gross Irri. Req. GIR	lit/s/ha		1.14	1.16	1.06	0.97	0.89	0.77	0.02	1.37	1.64	1.02	0.94	0.98	1.79	1.83	1.74	1.44	1.32	1.09	0.03	0.68	0.93	1.91	1.60	1.60	0.73	0.77	0.75	0.09	0.00	0.00	0.00	0.40	0.45	0.88	0.55	0.60			
Monthly Ave.			Gross Irri. Req. GIR	lit/s/ha			1.12			0.88			1.03			0.98			1.79			1.28			0.56			1.70			0.75			0.03			0.28			0.67		0.923	0.925 lit/s/ha	
Area			25,000 ha				28.0 m^3/s			22.0 m^3/s			25.8 m^3/s			24.5 m^3/s			44.8 m^3/s			32.0 m^3/s			14.0 m^3/s			42.5 m^3/s			18.8 m^3/s			0.8 m^3/s			7.0 m^3/s			16.8 m^3/s			23.1 m^3/s	

Table F.7 Irrigation Water Requirement, Kone, 2010, 1/4 Drought Year

Kone River Basin **(using ETo data in Quy Nhon, Rainfall data in Phu Cat, Future Cropping Pattern (2010)**

No.	Year	No.	Crop	Cropping Area (ha)	Area Ratio	Jan. 1	Jan. 2	Jan. 3	Feb. 1	Feb. 2	Feb. 3	Mar. 1	Mar. 2	Mar. 3	Apr. 1	Apr. 2	Apr. 3	May 1	May 2	May 3	Jun. 1	Jun. 2	Jun. 3	Jul. 1	Jul. 2	Jul. 3	Aug. 1	Aug. 2	Aug. 3	Sep. 1	Sep. 2	Sep. 3	Oct. 1	Oct. 2	Oct. 3	Nov. 1	Nov. 2	Nov. 3	Dec. 1	Dec. 2	Dec. 3	Total (mm/period)	Gross Requirement Depth (mm/year)	Gross Requirement Volume (m3/year/ha)
			Potential Evapotranspiration (ETo)	mm/month			105			110			141			159			176			182			191			184			152			124			103			96		1,723		
			Potential Evapotranspiration (ETo)	mm/10-day		35	35	35	37	37	36	47	47	47	53	53	53	58	58	60	61	61	60	63	63	65	61	61	62	51	51	50	41	41	42	34	34	35	32	32	32	1,723		
			Effective Rainfall (Pe)			5	5	7	17	17	20	2	2	4	1	1	3	0	0	1	23	23	24	43	43	43	3	3	3	47	47	47	69	69	70	53	53	52	26	26	25	877		
A	**Winter - Spring Crops**																																											
	1988	**1.**	**Paddy**	**32,000**	**0.88**																																							
		a	**Land Preparation (60 mm)**																																	**20.0**	**20.0**	**20.0**			60		
			Area (A %)																																	*33*	*67*						
		b	Evaporation (ETo*1.1*A%)																																	12.3	25.8				38		
		c	Percolation (2mm/day*A%)																																	6.6	13.4				20		
		d	Total Land Preparation Req. (a+b+c)																																	38.9	59.2	20.0			118		
			Crop Coefficient (kc)			*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																										*1.05*	*1.11*	*1.20*			
		e	**Crop Water Req. (CWR)**			**45.5**	**46.9**	**47.3**	**48.5**	**44.4**	**36.7**	**0.0**																										**33.6**	**35.5**	**38.4**	**377**		
		f	Percolation (2mm/day)			20.0	20.0	22.0	20.0	20.0	16.0	0.0																										20.0	20.0	22.0	180		
		g	Consumptive Use (CUW) (d+e+f)			65.5	66.9	69.3	68.5	64.4	52.7	0.0																								38.9	59.2	73.6	55.5	60.4	675		
		h	Effective Rainfall (Pe*A% or Pe)			5.0	5.0	7.0	17.0	17.0	20.0	2.0																								17.5	34.8	26.0	26.0	25.0	202		
		i	Net Irri. Req. (NIR)	mm/10-day		60.5	61.9	62.3	51.5	47.4	32.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.5	24.4	47.6	29.5	35.4	475	730	**7,301**
		2.	**Upland Crops**	**2,000**	**0.05**																																							
			Crop Coefficient (kc) (Tomato)			*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*																							*0.35*	*0.38*	*0.45*			
			Crop Water Req. (CWR)			**20.3**	**25.9**	**30.8**	**37.0**	**40.0**	**38.9**	**49.4**	**44.7**	**30.1**	**13.3**																							**11.2**	**12.2**	**14.4**	**368**		
			Effective rainfall (Pe)			5.0	5.0	7.0	17.0	17.0	20.0	2.0	2.0	4.0	1.0																							26.0	26.0	25.0	157		
			Net Irri. Req. (NIR)	mm/10-day		15.3	20.9	23.8	20.0	23.0	18.9	47.4	42.7	26.1	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	250	385	**3,849**
B	**Summer - Autumn Crops**																																											
	1988	**1.**	**Paddy**	**28,000**	**0.77**																																							
		a	**Land Preparation (150 mm)**										**50.0**	**50.0**	**50.0**																										150		
			Area (A %)										*33*	*67*																													
		b	Evaporation (ETo*1.1*A%)										17.1	34.6																													
		c	Percolation (2mm/day*A%)										6.6	14.7																													
		d	Total Land Preparation Req. (a+b+c)										73.7	99.4	50.0																												
			Crop Coefficient (kc)												*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																		
		e	**Crop Water Req. (CWR)**												**55.7**	**58.8**	**63.6**	**75.4**	**77.7**	**81.0**	**79.9**	**73.2**	**61.2**	**0.0**																	**627**		
		f	Percolation (2mm/day)												20.0	20.0	20.0	20.0	20.0	22.0	20.0	20.0	20.0	0.0																	182		
		g	Consumptive Use (CUW) (d+e+f)										73.7	99.4	85.7	78.8	83.6	95.4	97.7	103.0	99.9	93.2	81.2	0.0																	1032		
		h	Effective Rainfall (Pe*A% or Pe)										0.7	2.7	1.0	1.0	3.0	0.0	0.0	1.0	23.0	23.0	24.0	43.0																	122		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.0	96.7	84.7	77.8	80.6	95.4	97.7	102.0	76.9	70.2	57.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	828	1,273	**12,732**
		2.	**Upland Crops**	**c2+d2+f2**	**6,000**	**0.16**																																						
			Crop Coefficient (kc) (Tomato)														*0.35*	*0.38*	*0.45*	*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*														
			Crop Water Req. (CWR)														**18.6**	**22.0**	**26.1**	**34.8**	**45.1**	**53.7**	**60.0**	**68.0**	**68.0**	**68.3**	**58.0**	**39.0**	**15.5**													**577**		
			Effective rainfall (Pe)														3.0	0.0	0.0	1.0	23.0	23.0	24.0	16.0	16.0	15.0	17.0	17.0	19.0													174		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.6	22.0	26.1	33.8	22.1	30.7	36.0	52.0	52.0	53.3	41.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	407	626	**6,256**
C	**Rainy Season Crops**																																											
	1988	**1.**	**Paddy**	**32,000**	**0.88**																																							
		a	**Land Preparation (60 mm)**																						**20.0**	**20.0**	20.00														60		
			Area (A %)																						*33*	**67.00**																	
		b	Evaporation (ETo*1.1*A%)																						22.9	47.9																	
		c	Percolation (2mm/day*A%)																						6.6	14.7																	
		d	Total Land Preparation Req. (a+b+c)																						49.5	82.6	20.00																
			Crop Coefficient (kc)																								*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*						
		e	**Crop Water Req. (CWR)**																								**64.1**	**67.7**	**74.4**	**66.3**	**68.3**	**67.5**	**53.7**	**49.2**	**42.8**	**0.0**						**554**		
		f	Percolation (2mm/day)																								20.0	20.0	22.0	20.0	20.0	20.0	20.0	20.0	22.0	0.0						184		
		g	Consumptive Use (CUW) (d+e+f)																						49.5	82.6	104.1	87.7	96.4	86.3	88.3	87.5	73.7	69.2	64.8	0.0						890		
		h	Effective Rainfall (Pe*A% or Pe)																						14.2	28.8	3.0	3.0	3.0	47.0	47.0	47.0	69.0	69.0	70.0	53.0						454		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.3	53.8	101.1	84.7	93.4	39.3	41.3	40.5	4.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	494	760	**7,605**
		2.	**Upland Crops**	**0**	**0.00**																																							
			Crop Coefficient (kc) (Tomato)																																									
			Crop Water Req. (CWR)																																						**0**		
			Effective rainfall (Pe)																																						0		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	-
D	**Year Round Crop**																																											
	1988	**1.**	**Upland Crops**	**2,500**	**0.07**																																							
			Crop Coefficient (kc) (Sugar Cane)			*0.97*	*0.92*	*0.85*	*0.78*	*0.71*	*0.60*	*0.55*	*0.50*	*0.50*	*0.50*	*0.50*	*0.00*	*0.55*	*0.57*	*0.65*	*0.75*	*0.85*	*0.95*	*1.00*	*1.05*	*1.08*	*1.11*	*1.14*	*1.15*	*1.15*	*1.16*	*1.15*	*1.15*	*1.14*	*1.13*	*1.12*	*1.10*	*1.08*	*1.06*	*1.03*	*1.00*			
			Crop Water Req. (CWR)			**34.0**	**32.2**	**29.8**	**28.9**	**26.3**	**21.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.9**	**33.1**	**39.0**	**45.8**	**51.9**	**57.0**	**63.0**	**66.2**	**70.2**	**67.7**	**69.5**	**71.3**	**58.7**	**59.2**	**57.5**	**47.2**	**46.7**	**47.5**	**38.1**	**37.4**	**37.8**	**33.9**	**33.0**	**32.0**	**1368**		
			Effective rainfall (Pe)			5.0	5.0	7.0	17.0	17.0	20.0	2.0	2.0	4.0	1.0	1.0	3.0	0.0	0.0	1.0	23.0	23.0	24.0	43.0	43.0	43.0	3.0	3.0	3.0	47.0	47.0	47.0	69.0	69.0	70.0	53.0	53.0	52.0	26.0	26.0	25.0	877		
			Net Irri. Req. (NIR)	mm/10-day		29.0	27.2	22.8	11.9	9.3	1.6	0.0	0.0	0.0	0.0	0.0	0.0	31.9	33.1	38.0	22.8	28.9	33.0	20.0	23.2	27.2	64.7	66.5	68.3	11.7	12.2	10.5	0.0	0.0	0.0	0.0	0.0	0.0	7.9	7.0	7.0	615	947	**9,466**
					102,500	2.81																																						
			Weighted Ave. NIR	Total	**36,500**	**1.00**	55.9	57.3	57.4	47.0	43.5	29.8	2.6	58.3	75.6	65.8	59.7	64.4	79.0	81.5	86.4	64.2	60.9	52.1	9.9	41.1	57.8	99.8	82.5	86.6	35.3	37.1	36.2	4.1	0.2	0.0	0.0	18.8	21.4	42.3	26.4	31.5		**2,472**	**24,723**
			Gross Irri. Req. GIR	mm/10-day	Irri. Efficiency **0.65**	85.9	88.1	88.4	72.4	66.9	45.9	4.0	89.8	116.3	101.3	91.9	99.1	121.5	125.4	132.9	98.8	93.7	80.1	15.3	63.2	88.9	153.5	126.9	133.2	54.2	57.1	55.7	6.4	0.3	0.0	0.0	28.9	32.9	65.0	40.6	48.5			
			Gross Irri. Req. GIR	lit/s/ha		0.99	1.02	0.93	0.84	0.77	0.66	0.05	1.04	1.22	0.78	0.69	0.75	1.41	1.45	1.40	1.14	1.08	0.93	0.18	0.73	0.94	1.78	1.47	1.40	0.63	0.66	0.65	0.07	0.00	0.00	0.00	0.33	0.38	0.75	0.47	0.51			
Monthly Ave.			Gross Irri. Req. GIR	lit/s/ha			0.98			0.76			0.78			0.74			1.42			1.05			0.63			1.55			0.65			0.02			0.24			0.57		0.783	0.784 lit/s/ha	
Area			36,500 ha				35.8 m^3/s			27.7 m^3/s			28.5 m^3/s			27.0 m^3/s			51.8 m^3/s			38.3 m^3/s			23.0 m^3/s			56.6 m^3/s			23.7 m^3/s			0.7 m^3/s			8.8 m^3/s			20.8 m^3/s			28.6 m^3/s	

Table F.8 Irrigation Water Requirement, Kone, 2020, 1/4 Drought Year

Kone River Basin **(using ETo data in Quy Nhon, Rainfall data in Phu Cat, Future Cropping Pattern (2020)**

No.	Year	No.	Crop	Cropping Code	Cropping Area	Area Ratio	Jan. 1	Jan. 2	Jan. 3	Feb. 1	Feb. 2	Feb. 3	Mar. 1	Mar. 2	Mar. 3	Apr. 1	Apr. 2	Apr. 3	May 1	May 2	May 3	Jun. 1	Jun. 2	Jun. 3	Jul. 1	Jul. 2	Jul. 3	Aug. 1	Aug. 2	Aug. 3	Sep. 1	Sep. 2	Sep. 3	Oct. 1	Oct. 2	Oct. 3	Nov. 1	Nov. 2	Nov. 3	Dec. 1	Dec. 2	Dec. 3	Total (mm/period)	Gross Requirement Depth (mm/year)	Gross Requirement Volume (m3/year/ha)
					No.	(ha)																																						
			Potential Evapotranspiration (ETo)		mm/month			105			110			141			159			176			182			191			184			152			124			103			96		1,723		
			Potential Evapotranspiration (ETo)		mm/10-day		35	35	35	37	37	36	47	47	47	53	53	53	58	58	60	61	61	60	63	63	65	61	61	62	51	51	50	41	41	42	34	34	35	32	32	32	1,723		
			Effective Rainfall (Pe)				5	5	7	17	17	20	2	2	4	1	1	3	0	0	1	23	23	24	43	43	43	3	3	3	47	47	47	69	69	70	53	53	52	26	26	25	877		
A	**Winter - Spring Crops**																																											
	1988	**1.**	**Paddy**	**a1**	**40,000**	**0.82**																																						
			a **Land Preparation (60 mm)**																																		**20.0**	**20.0**	**20.0**			60		
			Area (A %)																																		*33*	*67*						
			b Evaporation (ETo*1.1*A%)																																		12.3	25.8				38		
			c Percolation (2mm/day*A%)																																		6.6	13.4				20		
			d Total Land Preparation Req. (a+b+c)																																		38.9	59.2	20.0			118		
			Crop Coefficient (kc)				*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																										*1.05*	*1.11*	*1.20*			
			e **Crop Water Req. (CWR)**				**45.5**	**46.9**	**47.3**	**48.5**	**44.4**	**36.7**	**0.0**																										**33.6**	**35.5**	**38.4**	**377**		
			f Percolation (2mm/day)				20.0	20.0	22.0	20.0	20.0	16.0	0.0																										20.0	20.0	22.0	180		
			g Consumptive Use (CUW) (d+e+f)				65.5	66.9	69.3	68.5	64.4	52.7	0.0																								38.9	59.2	73.6	55.5	60.4	675		
			h Effective Rainfall (Pe*A% or Pe)				5.0	5.0	7.0	17.0	17.0	20.0	2.0																								17.5	34.8	26.0	26.0	25.0	202		
			i Net Irri. Req. (NIR)		mm/10-day		60.5	61.9	62.3	51.5	47.4	32.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.5	24.4	47.6	29.5	35.4	475	678	**6,780**
		2.	**Upland Crops**	**c1+d1+f1**	**3,000**	**0.06**																																						
			Crop Coefficient (kc) (Tomato)				*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*																							*0.35*	*0.38*	*0.45*			
			Crop Water Req. (CWR)				**20.3**	**25.9**	**30.8**	**37.0**	**40.0**	**38.9**	**49.4**	**44.7**	**30.1**	**13.3**																							**11.2**	**12.2**	**14.4**	**368**		
			Effective rainfall (Pe)				5.0	5.0	7.0	17.0	17.0	20.0	2.0	2.0	4.0	1.0																							26.0	26.0	25.0	157		
			Net Irri. Req. (NIR)		mm/10-day		15.3	20.9	23.8	20.0	23.0	18.9	47.4	42.7	26.1	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	250	357	**3,574**
B	**Summer - Autumn Crops**																																											
	1988	**1.**	**Paddy**	**a2**	**28,000**	**0.57**																																						
			a **Land Preparation (150 mm)**											**50.0**	**50.0**	**50.0**																										150		
			Area (A %)											*33*	*67*																													
			b Evaporation (ETo*1.1*A%)											17.1	34.6																													
			c Percolation (2mm/day*A%)											6.6	14.7																													
			d Total Land Preparation Req. (a+b+c)											73.7	99.4	50.0																												
			Crop Coefficient (kc)													*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																		
			e **Crop Water Req. (CWR)**													**55.7**	**58.8**	**63.6**	**75.4**	**77.7**	**81.0**	**79.9**	**73.2**	**61.2**	**0.0**																	**627**		
			f Percolation (2mm/day)													20.0	20.0	20.0	20.0	20.0	22.0	20.0	20.0	20.0	0.0																	182		
			g Consumptive Use (CUW) (d+e+f)											73.7	99.4	85.7	78.8	83.6	95.4	97.7	103.0	99.9	93.2	81.2	0.0																	1032		
			h Effective Rainfall (Pe*A% or Pe)											0.7	2.7	1.0	1.0	3.0	0.0	0.0	1.0	23.0	23.0	24.0	43.0																	122		
			i Net Irri. Req. (NIR)		mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.0	96.7	84.7	77.8	80.6	95.4	97.7	102.0	76.9	70.2	57.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	828	1,182	**11,822**
		2.	**Upland Crops**	**c2+d2+f2**	**15,000**	**0.31**																																						
			Crop Coefficient (kc) (Tomato)															*0.35*	*0.38*	*0.45*	*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*													
			Crop Water Req. (CWR)															**18.6**	**22.0**	**26.1**	**34.8**	**45.1**	**53.7**	**60.0**	**68.0**	**68.0**	**68.3**	**58.0**	**39.0**	**15.5**													**577**		
			Effective rainfall (Pe)															3.0	0.0	0.0	1.0	23.0	23.0	24.0	16.0	16.0	15.0	17.0	17.0	19.0													174		
			Net Irri. Req. (NIR)		mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.6	22.0	26.1	33.8	22.1	30.7	36.0	52.0	52.0	53.3	41.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	407	581	**5,809**
C	**Rainy Season Crops**																																											
	1988	**1.**	**Paddy**	**a3**	**40,000**	**0.82**																																						
			a **Land Preparation (60 mm)**																						**20.0**	**20.0**	20.00															60		
			Area (A %)																						*33*	**67.00**																		
			b Evaporation (ETo*1.1*A%)																						22.9	47.9																		
			c Percolation (2mm/day*A%)																						6.6	14.7																		
			d Total Land Preparation Req. (a+b+c)																						49.5	82.6	20.00																	
			Crop Coefficient (kc)																									*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*						
			e **Crop Water Req. (CWR)**																									**64.1**	**67.7**	**74.4**	**66.3**	**68.3**	**67.5**	**53.7**	**49.2**	**42.8**	**0.0**						**554**		
			f Percolation (2mm/day)																									20.0	20.0	22.0	20.0	20.0	20.0	20.0	20.0	22.0	0.0						184		
			g Consumptive Use (CUW) (d+e+f)																						49.5	82.6	104.1	87.7	96.4	86.3	88.3	87.5	73.7	69.2	64.8	0.0						890		
			h Effective Rainfall (Pe*A% or Pe)																						14.2	28.8	3.0	3.0	3.0	47.0	47.0	47.0	69.0	69.0	70.0	53.0						454		
			i Net Irri. Req. (NIR)		mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.3	53.8	101.1	84.7	93.4	39.3	41.3	40.5	4.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	494	706	**7,062**
		2.	**Upland Crops**	**b3**	**0**	**0.00**																																						
			Crop Coefficient (kc) (Tomato)																																									
			Crop Water Req. (CWR)																																							**0**		
			Effective rainfall (Pe)																																							0		
			Net Irri. Req. (NIR)		mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	-
D	**Year Round Crop**																																											
	1988	**1.**	**Upland Crops**	**e4+g4+h4**	**6,000**	**0.12**																																						
			Crop Coefficient (kc) (Sugar Cane)				*0.97*	*0.92*	*0.85*	*0.78*	*0.71*	*0.60*	*0.55*	*0.50*	*0.50*	*0.50*	*0.50*	*0.00*	*0.55*	*0.57*	*0.65*	*0.75*	*0.85*	*0.95*	*1.00*	*1.05*	*1.08*	*1.11*	*1.14*	*1.15*	*1.15*	*1.16*	*1.15*	*1.15*	*1.14*	*1.13*	*1.12*	*1.10*	*1.08*	*1.06*	*1.03*	*1.00*			
			Crop Water Req. (CWR)				**34.0**	**32.2**	**29.8**	**28.9**	**26.3**	**21.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.9**	**33.1**	**39.0**	**45.8**	**51.9**	**57.0**	**63.0**	**66.2**	**70.2**	**67.7**	**69.5**	**71.3**	**58.7**	**59.2**	**57.5**	**47.2**	**46.7**	**47.5**	**38.1**	**37.4**	**37.8**	**33.9**	**33.0**	**32.0**	**1368**		
			Effective rainfall (Pe)				5.0	5.0	7.0	17.0	17.0	20.0	2.0	2.0	4.0	1.0	1.0	3.0	0.0	0.0	1.0	23.0	23.0	24.0	43.0	43.0	43.0	3.0	3.0	3.0	47.0	47.0	47.0	69.0	69.0	70.0	53.0	53.0	52.0	26.0	26.0	25.0	877		
			Net Irri. Req. (NIR)		mm/10-day		29.0	27.2	22.8	11.9	9.3	1.6	0.0	0.0	0.0	0.0	0.0	0.0	31.9	33.1	38.0	22.8	28.9	33.0	20.0	23.2	27.2	64.7	66.5	68.3	11.7	12.2	10.5	0.0	0.0	0.0	0.0	0.0	0.0	7.9	7.0	7.0	615	879	**8,790**
					132,000	2.69																																						
			Weighted Ave. NIR	Total	**49,000**	**1.00**	53.9	55.1	55.1	44.7	41.2	28.1	2.9	44.3	56.9	49.0	44.5	50.8	65.2	67.9	73.3	53.5	53.0	47.8	18.4	47.6	63.6	103.0	84.1	84.6	33.5	35.2	34.4	3.8	0.2	0.0	0.0	17.5	19.9	39.8	25.0	29.8		**2,113**	**21,128**
			Gross Irri. Req. GIR	mm/10-day	Irri. Efficiency	**0.70**	77.0	78.8	78.7	63.8	58.9	40.1	4.1	63.3	81.2	70.0	63.5	72.6	93.1	97.0	104.7	76.4	75.8	68.2	26.3	67.9	90.8	147.1	120.1	120.9	47.9	50.3	49.1	5.5	0.2	0.0	0.0	25.0	28.4	56.9	35.6	42.5			
			Gross Irri. Req. GIR	lit/s/ha			0.89	0.91	0.83	0.74	0.68	0.58	0.05	0.73	0.85	0.56	0.48	0.55	1.08	1.12	1.10	0.88	0.88	0.79	0.30	0.79	0.96	1.70	1.39	1.27	0.55	0.58	0.57	0.06	0.00	0.00	0.00	0.29	0.33	0.66	0.41	0.45			
Monthly Ave.			Gross Irri. Req. GIR	lit/s/ha			0.88			0.67			0.55			0.53			1.10			0.85			0.69			1.45			0.57			0.02			0.21			0.50			0.668	0.670 lit/s/ha	
Area			49,000 ha				43.1 m^3/s			32.8 m^3/s			27.0 m^3/s			26.0 m^3/s			53.9 m^3/s			41.7 m^3/s			33.8 m^3/s			71.1 m^3/s			27.9 m^3/s			1.0 m^3/s			10.3 m^3/s			24.5 m^3/s			32.8 m^3/s		

Table F.9 Effective Rainfall (Peff)

Averaga Rainfall Year

River Basin / Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total (mm/year)
01. Bang Giang	Ptot (mm/month)	21	42	49	84	173	201	257	250	167	85	35	28	1,392
Lang Son	Peff (mm/month)	20	39	45	73	125	136	151	150	122	73	33	27	994
	%	*95*	*93*	*92*	*87*	*72*	*68*	*59*	*60*	*73*	*86*	*94*	*96*	*71*
02. Red	Ptot (mm/month)	25	34	42	101	193	235	293	318	260	142	50	34	1,727
Hanoi	Peff (mm/month)	24	32	39	85	133	147	154	157	151	110	46	32	1,110
	%	*96*	*94*	*93*	*84*	*69*	*63*	*53*	*49*	*58*	*77*	*92*	*94*	*64*
03. Ma	Ptot (mm/month)	33	44	52	68	159	168	190	270	394	250	82	35	1,745
Thanh Hoa	Peff (mm/month)	31	41	48	61	119	123	132	152	164	150	71	33	1,125
	%	*94*	*93*	*92*	*90*	*75*	*73*	*69*	*56*	*42*	*60*	*87*	*94*	*64*
04. Ca	Ptot (mm/month)	33	44	52	68	159	168	190	270	394	250	82	35	1,745
Thanh Hoa (nearest in ATLAS)	Peff (mm/month)	31	41	48	61	119	123	132	152	164	150	71	33	1,125
	%	*94*	*93*	*92*	*90*	*75*	*73*	*69*	*56*	*42*	*60*	*87*	*94*	*64*
05. Thach Han	Ptot (mm/month)	158	57	43	57	86	115	100	115	459	789	574	315	2,868
Hue (nearest in ATLAS)	Peff (mm/month)	118	52	40	52	74	94	84	94	171	204	182	157	1,322
	%	*75*	*91*	*93*	*91*	*86*	*82*	*84*	*82*	*37*	*26*	*32*	*50*	*46*
06. Huong	Ptot (mm/month)	158	57	43	57	86	115	100	115	459	789	574	315	2,868
Hue	Peff (mm/month)	118	52	40	52	74	94	84	94	171	204	182	157	1,322
	%	*75*	*91*	*93*	*91*	*86*	*82*	*84*	*82*	*37*	*26*	*32*	*50*	*46*
07. Thu Bon	Ptot (mm/month)	82	41	31	41	51	71	72	102	327	777	348	102	2,045
Da Nang	Peff (mm/month)	71	38	29	38	47	63	64	85	158	203	160	85	1,041
	%	*87*	*93*	*94*	*93*	*92*	*89*	*89*	*83*	*48*	*26*	*46*	*83*	*51*
08. Tra Khuc	Ptot (mm/month)	137	57	34	46	69	92	80	126	275	585	527	263	2,291
Quang Ngai	Peff (mm/month)	107	52	32	43	61	78	70	101	153	184	178	151	1,210
	%	*78*	*91*	*94*	*93*	*88*	*85*	*88*	*80*	*56*	*31*	*34*	*57*	*53*
09. Kone	Ptot (mm/month)	59	34	25	42	68	59	51	59	237	458	432	169	1,693
Quy Nhon	Peff (mm/month)	53	32	24	39	61	53	47	53	147	171	168	123	971
	%	*90*	*94*	*96*	*93*	*90*	*90*	*92*	*90*	*62*	*37*	*39*	*73*	*57*
10. Ba	Ptot (mm/month)	48	20	41	41	54	48	41	54	163	312	367	170	1,359
Nha Trang (nearest in ATLAS)	Peff (mm/month)	44	19	38	38	49	44	38	49	120	156	162	124	881
	%	*92*	*95*	*93*	*93*	*91*	*92*	*93*	*91*	*74*	*50*	*44*	*73*	*65*
11. Sesan	Ptot (mm/month)	2	13	36	108	198	253	316	334	316	144	63	22	1,805
Kon Tum	Peff (mm/month)	2	13	34	89	135	150	157	158	157	111	57	21	1,084
	%	*100*	*100*	*94*	*82*	*68*	*59*	*50*	*47*	*50*	*77*	*90*	*95*	*60*
12. Srepok	Ptot (mm/month)	3	6	18	64	147	158	176	188	196	141	64	12	1,173
Buon Ma Thout	Peff (mm/month)	3	6	17	57	112	118	126	131	135	109	57	12	883
	%	*100*	*100*	*94*	*89*	*76*	*75*	*72*	*70*	*69*	*77*	*89*	*100*	*75*
13. Dong Nai	Ptot (mm/month)	4	10	14	50	220	309	290	274	307	268	125	60	1,931
Ho Chi Minh (nearest in ATLAS)	Peff (mm/month)	4	10	14	46	143	156	154	152	156	152	100	54	1,141
	%	*100*	*100*	*100*	*92*	*65*	*50*	*53*	*55*	*51*	*57*	*80*	*90*	*59*
14. Cuu Long Delta	Ptot (mm/month)	7	10	15	53	181	204	227	178	275	283	162	53	1,648
Can Tho	Peff (mm/month)	7	10	15	49	129	137	145	127	153	153	120	49	1,094
	%	*100*	*100*	*100*	*92*	*71*	*67*	*64*	*71*	*56*	*54*	*74*	*92*	*66*

Note. Rainfall data in Vietnam Hydrometeological ATLAS, 1994 are used. Ptot: Rainfall, Peff: Effective rainfall

Table F.10 Gross Unit Irrigation Requirement (GIR) and Irrigation Water Demand (IWD), 2001

Present Cropping Pattern (2001), Averaga Rainfall Year

River Basin / Irri. Area		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average
01. Bang Giang	GIR (lit/sec/ha)	0.28	0.13	0.17	0.27	0.19	0.00	0.60	0.29	0.58	0.76	0.74	0.01	0.33
25,500 ha	IWD (m^3/sec)	7.1	3.3	4.3	6.9	4.8	0.0	15.3	7.4	14.8	19.4	18.9	0.3	8.5
02. Red	GIR (lit/sec/ha)	1.05	0.53	0.59	0.49	0.45	0.00	0.41	0.20	0.30	0.41	0.53	0.03	0.42
1,008,000 ha	IWD (m^3/sec)	1,058.4	534.2	594.7	493.9	453.6	0.0	413.3	201.6	302.4	413.3	534.2	30.2	419.0
03. Ma	GIR (lit/sec/ha)	0.62	0.39	0.47	0.61	0.46	0.00	0.72	0.29	0.24	0.28	0.41	0.01	0.38
112,000 ha	IWD (m^3/sec)	69.4	43.7	52.6	68.3	51.5	0.0	80.6	32.5	26.9	31.4	45.9	1.1	42.0
04. Ca	GIR (lit/sec/ha)	0.93	0.36	0.51	0.61	0.14	0.41	0.76	0.48	0.22	0.06	0.04	0.00	0.38
93,000 ha	IWD (m^3/sec)	86.5	33.5	47.4	56.7	13.0	38.1	70.7	44.6	20.5	5.6	3.7	0.0	35.2
05. Thach Han	GIR (lit/sec/ha)	0.11	0.53	0.61	0.26	1.04	0.75	1.10	0.83	0.06	0.00	0.00	0.20	0.46
5,000 ha	IWD (m^3/sec)	0.6	2.7	3.1	1.3	5.2	3.8	5.5	4.2	0.3	0.0	0.0	1.0	2.3
06. Huong	GIR (lit/sec/ha)	0.09	0.49	0.62	0.39	0.90	0.71	0.92	0.30	0.00	0.00	0.00	0.18	0.38
25,900 ha	IWD (m^3/sec)	2.3	12.7	16.1	10.1	23.3	18.4	23.8	7.8	0.0	0.0	0.0	4.7	9.9
07. Thu Bon	GIR (lit/sec/ha)	0.33	0.63	0.77	0.25	0.16	0.11	0.87	0.63	0.18	0.00	0.00	0.48	0.37
30,900 ha	IWD (m^3/sec)	10.2	19.5	23.8	7.7	4.9	3.4	26.9	19.5	5.6	0.0	0.0	14.8	11.4
08. Tra Khuc	GIR (lit/sec/ha)	0.19	0.47	0.50	0.69	0.69	0.56	0.53	0.62	0.22	0.00	0.14	0.06	0.39
33,000 ha	IWD (m^3/sec)	6.3	15.5	16.5	22.8	22.8	18.5	17.5	20.5	7.3	0.0	4.6	2.0	12.8
09. Kone	GIR (lit/sec/ha)	0.90	1.04	1.00	0.84	1.41	1.39	0.74	1.43	0.71	0.22	0.26	0.40	0.86
25,000 ha	IWD (m^3/sec)	22.5	26.0	25.0	21.0	35.3	34.8	18.5	35.8	17.8	5.5	6.5	10.0	21.5
10. Ba	GIR (lit/sec/ha)	0.49	0.86	0.97	0.45	0.00	0.66	1.67	1.33	0.75	0.19	0.00	0.33	0.64
41,000 ha	IWD (m^3/sec)	20.1	35.3	39.8	18.5	0.0	27.1	68.5	54.5	30.8	7.8	0.0	13.5	26.4
11. Sesan	GIR (lit/sec/ha)	0.48	0.55	0.56	0.27	0.00	0.27	0.03	0.05	0.07	0.20	0.14	0.50	0.26
22,500 ha	IWD (m^3/sec)	10.8	12.4	12.6	6.1	0.0	6.1	0.7	1.1	1.6	4.5	3.2	11.3	5.8
12. Srepok	GIR (lit/sec/ha)	0.76	1.09	1.13	0.78	0.19	0.18	0.08	0.11	0.08	0.09	0.24	0.70	0.45
58,000 ha	IWD (m^3/sec)	44.1	63.2	65.5	45.2	11.0	10.4	4.6	6.4	4.6	5.2	13.9	40.6	26.0
13. Dong Nai	GIR (lit/sec/ha)	1.44	1.66	0.59	1.39	0.54	0.48	0.41	0.15	0.06	0.01	0.68	0.88	0.68
115,000 ha	IWD (m^3/sec)	165.6	190.9	67.9	159.9	62.1	55.2	47.2	17.3	6.9	1.2	78.2	101.2	78.5
14. Cuu Long Delta	GIR (lit/sec/ha)	1.22	1.27	0.40	1.64	0.48	0.48	0.40	0.15	0.02	0.00	0.60	0.86	0.62
1,487,000 ha	IWD (m^3/sec)	1,814.1	1,888.5	594.8	2,438.7	713.8	713.8	594.8	223.1	29.7	0.0	892.2	1,278.8	923.9

TableF.11 Gross Unit Irrigation Requirement (GIR) and Irrigation Water Demand (IWD), 2010

Future Cropping Pattern (2010), Averaga Rainfall Year

River Basin / Irri. Area		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average
01. Bang Giang	GIR (lit/sec/ha)	0.20	0.09	0.12	0.19	0.13	0.00	0.32	0.15	0.32	0.48	0.53	0.05	0.22
54,500 ha	IWD (m^3/sec)	10.9	4.9	6.5	10.4	7.1	0.0	17.4	8.2	17.4	26.2	28.9	2.7	11.8
02. Red	GIR (lit/sec/ha)	0.96	0.49	0.54	0.45	0.41	0.00	0.39	0.19	0.28	0.38	0.49	0.03	0.38
1,197,000 ha	IWD (m^3/sec)	1,149.1	586.5	646.4	538.7	490.8	0.0	466.8	227.4	335.2	454.9	586.5	35.9	459.9
03. Ma	GIR (lit/sec/ha)	0.51	0.32	0.38	0.50	0.38	0.00	0.54	0.22	0.18	0.21	0.31	0.04	0.30
176,000 ha	IWD (m^3/sec)	89.8	56.3	66.9	88.0	66.9	0.0	95.0	38.7	31.7	37.0	54.6	7.0	52.6
04. Ca	GIR (lit/sec/ha)	0.69	0.28	0.40	0.47	0.11	0.29	0.55	0.34	0.16	0.04	0.03	0.02	0.28
150,000 ha	IWD (m^3/sec)	103.5	42.0	60.0	70.5	16.5	43.5	82.5	51.0	24.0	6.0	4.5	3.0	42.3
05. Thach Han	GIR (lit/sec/ha)	0.09	0.41	0.51	0.27	0.75	0.58	0.83	0.62	0.05	0.00	0.00	0.15	0.36
12,300 ha	IWD (m^3/sec)	1.1	5.0	6.3	3.3	9.2	7.1	10.2	7.6	0.6	0.0	0.0	1.8	4.4
06. Huong	GIR (lit/sec/ha)	0.09	0.46	0.58	0.37	0.88	0.70	0.90	0.29	0.00	0.00	0.00	0.17	0.37
25,900 ha	IWD (m^3/sec)	2.3	11.9	15.0	9.6	22.8	18.1	23.3	7.5	0.0	0.0	0.0	4.4	9.6
07. Thu Bon	GIR (lit/sec/ha)	0.25	0.48	0.58	0.21	0.18	0.13	0.68	0.49	0.14	0.00	0.00	0.36	0.29
69,000 ha	IWD (m^3/sec)	17.3	33.1	40.0	14.5	12.4	9.0	46.9	33.8	9.7	0.0	0.0	24.8	20.1
08. Tra Khuc	GIR (lit/sec/ha)	0.15	0.38	0.40	0.56	0.56	0.48	0.43	0.46	0.15	0.00	0.11	0.05	0.31
42,000 ha	IWD (m^3/sec)	6.3	16.0	16.8	23.5	23.5	20.2	18.1	19.3	6.3	0.0	4.6	2.1	13.1
09. Kone	GIR (lit/sec/ha)	0.78	0.90	0.76	0.63	1.08	1.15	0.79	1.31	0.61	0.18	0.22	0.34	0.73
36,500 ha	IWD (m^3/sec)	28.5	32.9	27.7	23.0	39.4	42.0	28.8	47.8	22.3	6.6	8.0	12.4	26.6
10. Ba	GIR (lit/sec/ha)	0.28	0.53	0.53	0.32	0.11	0.46	1.20	0.98	0.48	0.11	0.00	0.14	0.43
129,000 ha	IWD (m^3/sec)	36.1	68.4	68.4	41.3	14.2	59.3	154.8	126.4	61.9	14.2	0.0	18.1	55.4
11. Sesan	GIR (lit/sec/ha)	0.54	0.64	0.69	0.34	0.00	0.16	0.02	0.03	0.04	0.12	0.17	0.54	0.27
35,400 ha	IWD (m^3/sec)	19.1	22.7	24.4	12.0	0.0	5.7	0.7	1.1	1.4	4.2	6.0	19.1	9.6
12. Srepok	GIR (lit/sec/ha)	0.54	0.86	1.00	0.73	0.15	0.17	0.08	0.11	0.08	0.09	0.18	0.48	0.37
97,000 ha	IWD (m^3/sec)	52.4	83.4	97.0	70.8	14.6	16.5	7.8	10.7	7.8	8.7	17.5	46.6	35.8
13. Dong Nai	GIR (lit/sec/ha)	0.72	0.86	0.35	0.72	0.28	0.42	0.34	0.25	0.14	0.03	0.31	0.41	0.40
255,000 ha	IWD (m^3/sec)	183.6	219.3	89.3	183.6	71.4	107.1	86.7	63.8	35.7	7.7	79.1	104.6	101.7
14. Cuu Long Delta	GIR (lit/sec/ha)	1.11	1.15	0.37	1.39	0.40	0.40	0.33	0.12	0.01	0.00	0.52	0.77	0.54
1,891,000 ha	IWD (m^3/sec)	2,099.0	2,174.7	699.7	2,628.5	756.4	756.4	624.0	226.9	18.9	0.0	983.3	1,456.1	1,023.8

Table F.12 Gross Unit Irrigation Requirement (GIR) and Irrigation Water Demand (IWD), 2020

Future Cropping Pattern (2020), Averaga Rainfall Year

River Basin / Irri. Area		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Average
01. Bang Giang	GIR (lit/sec/ha)	0.17	0.08	0.11	0.16	0.12	0.00	0.28	0.14	0.28	0.43	0.48	0.06	0.19
67,500 ha	IWD (m^3/sec)	11.5	5.4	7.4	10.8	8.1	0.0	18.9	9.5	18.9	29.0	32.4	4.1	13.0
02. Red	GIR (lit/sec/ha)	0.88	0.44	0.49	0.41	0.37	0.00	0.35	0.17	0.26	0.35	0.46	0.03	0.35
1,291,000 ha	IWD (m^3/sec)	1,136.1	568.0	632.6	529.3	477.7	0.0	451.9	219.5	335.7	451.9	593.9	38.7	453.9
03. Ma	GIR (lit/sec/ha)	0.50	0.30	0.36	0.48	0.36	0.00	0.47	0.18	0.15	0.19	0.28	0.05	0.28
199,500 ha	IWD (m^3/sec)	99.8	59.9	71.8	95.8	71.8	0.0	93.8	35.9	29.9	37.9	55.9	10.0	55.4
04. Ca	GIR (lit/sec/ha)	0.59	0.23	0.34	0.40	0.09	0.24	0.45	0.28	0.13	0.03	0.03	0.03	0.24
203,000 ha	IWD (m^3/sec)	119.8	46.7	69.0	81.2	18.3	48.7	91.4	56.8	26.4	6.1	6.1	6.1	48.2
05. Thach Han	GIR (lit/sec/ha)	0.07	0.35	0.43	0.25	0.70	0.55	0.73	0.54	0.03	0.00	0.00	0.13	0.32
15,400 ha	IWD (m^3/sec)	1.1	5.4	6.6	3.9	10.8	8.5	11.2	8.3	0.5	0.0	0.0	2.0	4.9
06. Huong	GIR (lit/sec/ha)	0.09	0.45	0.57	0.37	1.03	0.83	1.09	0.35	0.00	0.00	0.00	0.17	0.41
25,900 ha	IWD (m^3/sec)	2.3	11.7	14.8	9.6	26.7	21.5	28.2	9.1	0.0	0.0	0.0	4.4	10.7
07. Thu Bon	GIR (lit/sec/ha)	0.21	0.41	0.50	0.19	0.17	0.13	0.61	0.44	0.12	0.00	0.00	0.31	0.26
77,000 ha	IWD (m^3/sec)	16.2	31.6	38.5	14.6	13.1	10.0	47.0	33.9	9.2	0.0	0.0	23.9	19.9
08. Tra Khuc	GIR (lit/sec/ha)	0.12	0.31	0.31	0.41	0.43	0.38	0.36	0.36	0.11	0.00	0.09	0.04	0.24
54,000 ha	IWD (m^3/sec)	6.5	16.7	16.7	22.1	23.2	20.5	19.4	19.4	5.9	0.0	4.9	2.2	13.1
09. Kone	GIR (lit/sec/ha)	0.68	0.80	0.54	0.44	0.78	0.95	0.87	1.23	0.54	0.16	0.19	0.29	0.62
49,000 ha	IWD (m^3/sec)	33.3	39.2	26.5	21.6	38.2	46.6	42.6	60.3	26.5	7.8	9.3	14.2	30.4
10. Ba	GIR (lit/sec/ha)	0.22	0.44	0.41	0.27	0.13	0.42	1.07	0.88	0.41	0.09	0.00	0.09	0.36
186,000 ha	IWD (m^3/sec)	40.9	81.8	76.3	50.2	24.2	78.1	199.0	163.7	76.3	16.7	0.0	16.7	67.3
11. Sesan	GIR (lit/sec/ha)	0.51	0.61	0.66	0.32	0.00	0.12	0.01	0.03	0.03	0.09	0.17	0.49	0.25
50,000 ha	IWD (m^3/sec)	25.5	30.5	33.0	16.0	0.0	6.0	0.5	1.5	1.5	4.5	8.5	24.5	12.6
12. Srepok	GIR (lit/sec/ha)	0.50	0.80	0.93	0.68	0.15	0.13	0.06	0.08	0.06	0.06	0.18	0.42	0.34
149,000 ha	IWD (m^3/sec)	74.5	119.2	138.6	101.3	22.4	19.4	8.9	11.9	8.9	8.9	26.8	62.6	49.9
13. Dong Nai	GIR (lit/sec/ha)	0.53	0.67	0.35	0.44	0.17	0.35	0.28	0.25	0.15	0.03	0.19	0.26	0.30
393,000 ha	IWD (m^3/sec)	208.3	263.3	137.6	172.9	66.8	137.6	110.0	98.3	59.0	11.8	74.7	102.2	119.2
14. Cuu Long Delta	GIR (lit/sec/ha)	1.00	1.03	0.32	1.22	0.35	0.34	0.29	0.11	0.01	0.00	0.45	0.69	0.48
2,242,000 ha	IWD (m^3/sec)	2,242.0	2,309.3	717.4	2,735.2	784.7	762.3	650.2	246.6	22.4	0.0	1,008.9	1,547.0	1,075.9

Table F.13 Irrigation Water Requirement, Kone, 2001, Average Rainfall Year

Kone River Basin **(using data in Quy Nhon, Present Cropping Pattern (2001)**

No.	Year	No.	Crop	Cropping Area (ha)	Area Ratio	Jan. 1	Jan. 2	Jan. 3	Feb. 1	Feb. 2	Feb. 3	Mar. 1	Mar. 2	Mar. 3	Apr. 1	Apr. 2	Apr. 3	May 1	May 2	May 3	Jun. 1	Jun. 2	Jun. 3	Jul. 1	Jul. 2	Jul. 3	Aug. 1	Aug. 2	Aug. 3	Sep. 1	Sep. 2	Sep. 3	Oct. 1	Oct. 2	Oct. 3	Nov. 1	Nov. 2	Nov. 3	Dec. 1	Dec. 2	Dec. 3	Total (mm/period)	Gross Requirement Depth (mm/year)	Gross Requirement Volume (m3/year/ha)
						Cropping Period																																						
			Potential Evapotranspiration (ETo)	mm/month			105			110			141			159			176			182			191			184			152			124			103			96		1,723		
			Potential Evapotranspiration (ETo)	mm/10-day		35	35	35	37	37	36	47	47	47	53	53	53	58	58	60	61	61	60	63	63	65	61	61	62	51	51	50	41	41	42	34	34	35	32	32	32	1,723		
			Effective Rainfall (Pe)			17	17	19	11	11	10	8	8	8	13	13	13	20	20	21	18	18	17	16	16	15	17	17	19	49	49	49	57	57	57	56	56	56	41	41	41	971		
A	**Winter - Spring Crops**																																											
	Ave.	1.	**Paddy**	24,000	0.96																																							
		a	**Land Preparation (60 mm)**																																	**20.0**	**20.0**	**20.0**				60		
			Area (A %)																																	*33*	*67*							
		b	Evaporation (ETo*1.1*A%)																																	12.3	25.8					38		
		c	Percolation (2mm/day*A%)																																	6.6	13.4					20		
		d	Total Land Preparation Req. (a+b+c)																																	38.9	59.2	20.0				118		
			Crop Coefficient (kc)			*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																										*1.05*	*1.11*	*1.20*				
		e	**Crop Water Req. (CWR)**			**45.5**	**46.9**	**47.3**	**48.5**	**44.4**	**36.7**	**0.0**																										**33.6**	**35.5**	**38.4**	**377**		
		f	Percolation (2mm/day)			20.0	20.0	22.0	20.0	20.0	16.0	0.0																										20.0	20.0	22.0	180		
		g	Consumptive Use (CUW) (d+e+f)			65.5	66.9	69.3	68.5	64.4	52.7	0.0																								38.9	59.2	73.6	55.5	60.4	675		
		h	Effective Rainfall (Pe*A% or Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0																								18.5	37.5	41.0	41.0	41.0	272		
		i	Net Irri. Req. (NIR)	mm/10-day		48.5	49.9	50.3	57.5	53.4	42.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5	21.7	32.6	14.5	19.4	411	685	**6,848**
		2.	**Upland Crops**	500	0.02																																							
			Crop Coefficient (kc) (Tomato)			*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*																							*0.35*	*0.38*	*0.45*				
			Crop Water Req. (CWR)			**20.3**	**25.9**	**30.8**	**37.0**	**40.0**	**38.9**	**49.4**	**44.7**	**30.1**	**13.3**																							**11.2**	**12.2**	**14.4**	**368**		
			Effective rainfall (Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0	8.0	8.0	13.0																							41.0	41.0	41.0	245		
			Net Irri. Req. (NIR)	mm/10-day		3.3	8.9	11.8	26.0	29.0	28.9	41.4	36.7	22.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	208	347	**3,470**
B	**Summer - Autumn Crops**																																											
	Ave.	1.	**Paddy**	24,000	0.96																																							
		a	**Land Preparation (150 mm)**										**50.0**	**50.0**	**50.0**																											150		
			Area (A %)										*33*	*67*																														
		b	Evaporation (ETo*1.1*A%)										17.1	34.6																														
		c	Percolation (2mm/day*A%)										6.6	14.7																														
		d	Total Land Preparation Req. (a+b+c)										73.7	99.4	50.0																													
			Crop Coefficient (kc)												*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																				
		e	**Crop Water Req. (CWR)**												**55.7**	**58.8**	**63.6**	**75.4**	**77.7**	**81.0**	**79.9**	**73.2**	**61.2**	**0.0**																		**627**		
		f	Percolation (2mm/day)												20.0	20.0	20.0	20.0	20.0	22.0	20.0	20.0	20.0	0.0																		182		
		g	Consumptive Use (CUW) (d+e+f)										73.7	99.4	85.7	78.8	83.6	95.4	97.7	103.0	99.9	93.2	81.2	0.0																		1032		
		h	Effective Rainfall (Pe*A% or Pe)										2.6	5.4	13.0	13.0	13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0																		177		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.0	94.0	72.7	65.8	70.6	75.4	77.7	82.0	81.9	75.2	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	758	1,263	**12,632**
		2.	**Upland Crops**	500	0.02																																							
			Crop Coefficient (kc) (Tomato)														*0.35*	*0.38*	*0.45*	*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*															
			Crop Water Req. (CWR)														**18.6**	**22.0**	**26.1**	**34.8**	**45.1**	**53.7**	**60.0**	**68.0**	**68.0**	**68.3**	**58.0**	**39.0**	**15.5**													**577**		
			Effective rainfall (Pe)														13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0	16.0	15.0	17.0	17.0	19.0													227		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	2.0	6.1	13.8	27.1	35.7	43.0	52.0	52.0	53.3	41.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	354	589	**5,894**
C	**Rainy Season Crops**																																											
	Ave.	1.	**Paddy**	24,000	0.96																																							
		a	**Land Preparation (60 mm)**																					**20.0**	**20.0**	20.00																60		
			Area (A %)																					*33*	**67.00**																			
		b	Evaporation (ETo*1.1*A%)																					22.9	47.9																			
		c	Percolation (2mm/day*A%)																					6.6	14.7																			
		d	Total Land Preparation Req. (a+b+c)																					49.5	82.6	20.00																		
			Crop Coefficient (kc)																							*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*								
		e	**Crop Water Req. (CWR)**																							**64.1**	**67.7**	**74.4**	**66.3**	**68.3**	**67.5**	**53.7**	**49.2**	**42.8**	**0.0**							**554**		
		f	Percolation (2mm/day)																							20.0	20.0	22.0	20.0	20.0	20.0	20.0	20.0	22.0	0.0							184		
		g	Consumptive Use (CUW) (d+e+f)																					49.5	82.6	104.1	87.7	96.4	86.3	88.3	87.5	73.7	69.2	64.8	0.0							890		
		h	Effective Rainfall (Pe*A% or Pe)																					5.3	10.1	17.0	17.0	19.0	49.0	49.0	49.0	57.0	57.0	57.0	56.0							442		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.2	72.6	87.1	70.7	77.4	37.3	39.3	38.5	16.7	12.2	7.8	0.0	0.0	0.0	0.0	0.0	0.0	504	840	**8,397**
		2.	**Upland Crops**	0	0.00																																							
			Crop Coefficient (kc) (Tomato)																																									
			Crop Water Req. (CWR)																																							**0**		
			Effective rainfall (Pe)																																							0		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	-
D	**Year Round Crop**																																											
	Ave.	1.	**Upland Crops**	500	0.02																																							
			Crop Coefficient (kc) (Sugar Cane)			*0.97*	*0.92*	*0.85*	*0.78*	*0.71*	*0.60*	*0.55*	*0.50*	*0.50*	*0.50*	*0.50*	*0.00*	*0.55*	*0.57*	*0.65*	*0.75*	*0.85*	*0.95*	*1.00*	*1.05*	*1.08*	*1.11*	*1.14*	*1.15*	*1.15*	*1.16*	*1.15*	*1.15*	*1.14*	*1.13*	*1.12*	*1.10*	*1.08*	*1.06*	*1.03*	*1.00*			
			Crop Water Req. (CWR)			**34.0**	**32.2**	**29.8**	**28.9**	**26.3**	**21.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.9**	**33.1**	**39.0**	**45.8**	**51.9**	**57.0**	**63.0**	**66.2**	**70.2**	**67.7**	**69.5**	**71.3**	**58.7**	**59.2**	**57.5**	**47.2**	**46.7**	**47.5**	**38.1**	**37.4**	**37.8**	**33.9**	**33.0**	**32.0**	**1368**		
			Effective rainfall (Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0	8.0	8.0	13.0	13.0	13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0	16.0	15.0	17.0	17.0	19.0	49.0	49.0	49.0	57.0	57.0	57.0	56.0	56.0	56.0	41.0	41.0	41.0	971		
			Net Irri. Req. (NIR)	mm/10-day		17.0	15.2	10.8	17.9	15.3	11.6	0.0	0.0	0.0	0.0	0.0	0.0	11.9	13.1	18.0	27.8	33.9	40.0	47.0	50.2	55.2	50.7	52.5	52.3	9.7	10.2	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	568	947	**9,473**
						73,500	2.94																																					
			Weighted Ave. NIR	Total	**25,000**	**1.00**	47.0	48.4	48.7	56.1	52.2	41.8	0.8	68.9	90.7	69.8	63.2	67.9	72.7	75.0	79.4	79.7	73.6	63.3	2.0	44.5	71.9	85.4	69.4	75.4	36.0	38.0	37.1	16.0	11.7	7.5	0.0	19.6	20.8	31.3	13.9	18.6		**2,714**	**27,139**
			Gross Irri. Req. GIR	mm/10-day	Irri. Efficiency **0.60**	78.3	80.7	81.2	93.4	86.9	69.7	1.4	114.9	151.2	116.3	105.3	113.2	121.1	125.0	132.3	132.9	122.6	105.5	3.3	74.1	119.8	142.3	115.6	125.6	60.0	63.3	61.9	26.7	19.5	12.6	0.0	32.7	34.7	52.2	23.2	31.0			
			Gross Irri. Req. GIR	lit/s/ha		0.91	0.93	0.85	1.08	1.01	1.01	0.02	1.33	1.59	0.88	0.79	0.85	1.40	1.45	1.39	1.54	1.42	1.22	0.04	0.86	1.26	1.65	1.34	1.32	0.69	0.73	0.72	0.31	0.23	0.13	0.00	0.38	0.40	0.60	0.27	0.33			
Monthly Ave.			Gross Irri. Req. GIR	lit/s/ha			0.90			1.04			1.00			0.84			1.41			1.39			0.74			1.43			0.71			0.22			0.26			0.40		0.862	0.861 lit/s/ha	
Area			25,000 ha				22.5 m^3/s			26.0 m^3/s			25.0 m^3/s			21.0 m^3/s			35.3 m^3/s			34.8 m^3/s			18.5 m^3/s			35.8 m^3/s			17.8 m^3/s			5.5 m^3/s			6.5 m^3/s			10.0 m^3/s			21.5 m^3/s	

Table F.14 Irrigation Water Requirement, Kone, 2010, Average Rainfall Year

Kone River Basin **(using data in Quy Nhon, Future Cropping Pattern (2010)**

No.	Year	No.	Crop	Cropping Area (ha)	Area Ratio	Jan. 1	Jan. 2	Jan. 3	Feb. 1	Feb. 2	Feb. 3	Mar. 1	Mar. 2	Mar. 3	Apr. 1	Apr. 2	Apr. 3	May 1	May 2	May 3	Jun. 1	Jun. 2	Jun. 3	Jul. 1	Jul. 2	Jul. 3	Aug. 1	Aug. 2	Aug. 3	Sep. 1	Sep. 2	Sep. 3	Oct. 1	Oct. 2	Oct. 3	Nov. 1	Nov. 2	Nov. 3	Dec. 1	Dec. 2	Dec. 3	Total (mm/period)	Gross Requirement Depth (mm/year)	Gross Requirement Volume (m3/year/ha)
			Potential Evapotranspiration (ETo)	mm/month			105			110			141			159			176			182			191			184			152			124			103			96		1,723		
			Potential Evapotranspiration (ETo)	mm/10-day		35	35	35	37	37	36	47	47	47	53	53	53	58	58	60	61	61	60	63	63	65	61	61	62	51	51	50	41	41	42	34	34	35	32	32	32	1,723		
			Effective Rainfall (Pe)			17	17	19	11	11	10	8	8	8	13	13	13	20	20	21	18	18	17	16	16	15	17	17	19	49	49	49	57	57	57	56	56	56	41	41	41	971		
A	**Winter - Spring Crops**																																											
	Ave.	**1.**	**Paddy**	**32,000**	**0.88**																																							
		a	**Land Preparation (60 mm)**																																	**20.0**	**20.0**	**20.0**				60		
			Area (A %)																																	*33*	*67*							
		b	Evaporation (ETo*1.1*A%)																																	12.3	25.8					38		
		c	Percolation (2mm/day*A%)																																	6.6	13.4					20		
		d	Total Land Preparation Req. (a+b+c)																																	38.9	59.2	20.0				118		
			Crop Coefficient (kc)			*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																										*1.05*	*1.11*	*1.20*				
		e	**Crop Water Req. (CWR)**			**45.5**	**46.9**	**47.3**	**48.5**	**44.4**	**36.7**	**0.0**																										**33.6**	**35.5**	**38.4**	**377**		
		f	Percolation (2mm/day)			20.0	20.0	22.0	20.0	20.0	16.0	0.0																										20.0	20.0	22.0	180		
		g	Consumptive Use (CUW) (d+e+f)			65.5	66.9	69.3	68.5	64.4	52.7	0.0																								38.9	59.2	73.6	55.5	60.4	675		
		h	Effective Rainfall (Pe*A% or Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0																								18.5	37.5	41.0	41.0	41.0	272		
		i	Net Irri. Req. (NIR)	mm/10-day		48.5	49.9	50.3	57.5	53.4	42.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5	21.7	32.6	14.5	19.4	411	632	**6,321**
		2.	**Upland Crops**	**2,000**	**0.05**																																							
			Crop Coefficient (kc) (Tomato)			*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*																							*0.35*	*0.38*	*0.45*				
			Crop Water Req. (CWR)			**20.3**	**25.9**	**30.8**	**37.0**	**40.0**	**38.9**	**49.4**	**44.7**	**30.1**	**13.3**																							**11.2**	**12.2**	**14.4**	**368**		
			Effective rainfall (Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0	8.0	8.0	13.0																							41.0	41.0	41.0	245		
			Net Irri. Req. (NIR)	mm/10-day		3.3	8.9	11.8	26.0	29.0	28.9	41.4	36.7	22.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	208	320	**3,203**
B	**Summer - Autumn Crops**																																											
	Ave.	**1.**	**Paddy**	**28,000**	**0.77**																																							
		a	**Land Preparation (150 mm)**										**50.0**	**50.0**	**50.0**																											150		
			Area (A %)										*33*	*67*																														
		b	Evaporation (ETo*1.1*A%)										17.1	34.6																														
		c	Percolation (2mm/day*A%)										6.6	14.7																														
		d	Total Land Preparation Req. (a+b+c)										73.7	99.4	50.0																													
			Crop Coefficient (kc)												*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																			
		e	**Crop Water Req. (CWR)**												**55.7**	**58.8**	**63.6**	**75.4**	**77.7**	**81.0**	**79.9**	**73.2**	**61.2**	**0.0**																		**627**		
		f	Percolation (2mm/day)												20.0	20.0	20.0	20.0	20.0	22.0	20.0	20.0	20.0	0.0																		182		
		g	Consumptive Use (CUW) (d+e+f)										73.7	99.4	85.7	78.8	83.6	95.4	97.7	103.0	99.9	93.2	81.2	0.0																		1032		
		h	Effective Rainfall (Pe*A% or Pe)										2.6	5.4	13.0	13.0	13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0																		177		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.0	94.0	72.7	65.8	70.6	75.4	77.7	82.0	81.9	75.2	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	758	1,166	**11,660**
		2.	**Upland Crops**	**c2+d2+f2**	**6,000**	**0.16**																																						
			Crop Coefficient (kc) (Tomato)														*0.35*	*0.38*	*0.45*	*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*														
			Crop Water Req. (CWR)														**18.6**	**22.0**	**26.1**	**34.8**	**45.1**	**53.7**	**60.0**	**68.0**	**68.0**	**68.3**	**58.0**	**39.0**	**15.5**													**577**		
			Effective rainfall (Pe)														13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0	16.0	15.0	17.0	17.0	19.0													227		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	2.0	6.1	13.8	27.1	35.7	43.0	52.0	52.0	53.3	41.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	354	544	**5,440**
C	**Rainy Season Crops**																																											
	Ave.	**1.**	**Paddy**	**32,000**	**0.88**																																							
		a	**Land Preparation (60 mm)**																					**20.0**	**20.0**	20.00																60		
			Area (A %)																					*33*	**67.00**																			
		b	Evaporation (ETo*1.1*A%)																					22.9	47.9																			
		c	Percolation (2mm/day*A%)																					6.6	14.7																			
		d	Total Land Preparation Req. (a+b+c)																					49.5	82.6	20.00																		
			Crop Coefficient (kc)																							*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*							
		e	**Crop Water Req. (CWR)**																							**64.1**	**67.7**	**74.4**	**66.3**	**68.3**	**67.5**	**53.7**	**49.2**	**42.8**	**0.0**							**554**		
		f	Percolation (2mm/day)																							20.0	20.0	22.0	20.0	20.0	20.0	20.0	20.0	22.0	0.0							184		
		g	Consumptive Use (CUW) (d+e+f)																					49.5	82.6	104.1	87.7	96.4	86.3	88.3	87.5	73.7	69.2	64.8	0.0							890		
		h	Effective Rainfall (Pe*A% or Pe)																					5.3	10.1	17.0	17.0	19.0	49.0	49.0	49.0	57.0	57.0	57.0	56.0							442		
		i	Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.2	72.6	87.1	70.7	77.4	37.3	39.3	38.5	16.7	12.2	7.8	0.0	0.0	0.0	0.0	0.0	0.0	504	775	**7,751**
		2.	**Upland Crops**	**0**	**0.00**																																							
			Crop Coefficient (kc) (Tomato)																																									
			Crop Water Req. (CWR)																																							**0**		
			Effective rainfall (Pe)																																							0		
			Net Irri. Req. (NIR)	mm/10-day		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	-
D	**Year Round Crop**																																											
	Ave.	**1.**	**Upland Crops**	**2,500**	**0.07**																																							
			Crop Coefficient (kc) (Sugar Cane)			*0.97*	*0.92*	*0.85*	*0.78*	*0.71*	*0.60*	*0.55*	*0.50*	*0.50*	*0.50*	*0.50*	*0.00*	*0.55*	*0.57*	*0.65*	*0.75*	*0.85*	*0.95*	*1.00*	*1.05*	*1.08*	*1.11*	*1.14*	*1.15*	*1.15*	*1.16*	*1.15*	*1.15*	*1.14*	*1.13*	*1.12*	*1.10*	*1.08*	*1.06*	*1.03*	*1.00*			
			Crop Water Req. (CWR)			**34.0**	**32.2**	**29.8**	**28.9**	**26.3**	**21.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.9**	**33.1**	**39.0**	**45.8**	**51.9**	**57.0**	**63.0**	**66.2**	**70.2**	**67.7**	**69.5**	**71.3**	**58.7**	**59.2**	**57.5**	**47.2**	**46.7**	**47.5**	**38.1**	**37.4**	**37.8**	**33.9**	**33.0**	**32.0**	**1368**		
			Effective rainfall (Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0	8.0	8.0	13.0	13.0	13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0	16.0	15.0	17.0	17.0	19.0	49.0	49.0	49.0	57.0	57.0	57.0	56.0	56.0	56.0	41.0	41.0	41.0	971		
			Net Irri. Req. (NIR)	mm/10-day		17.0	15.2	10.8	17.9	15.3	11.6	0.0	0.0	0.0	0.0	0.0	0.0	11.9	13.1	18.0	27.8	33.9	40.0	47.0	50.2	55.2	50.7	52.5	52.3	9.7	10.2	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	568	874	**8,745**
					102,500	2.81																																						
			Weighted Ave. NIR	Total	**36,500**	**1.00**	43.9	45.3	45.4	53.0	49.5	39.8	2.3	56.5	73.3	56.0	50.5	55.1	59.0	61.5	66.4	69.2	65.9	59.1	11.8	50.7	76.2	86.5	69.2	71.4	33.4	35.2	34.3	14.7	10.7	6.9	0.0	17.9	19.0	28.6	12.7	17.0		**2,295**	**22,951**
			Gross Irri. Req. GIR	mm/10-day	Irri. Efficiency **0.65**	67.5	69.7	69.9	81.6	76.1	61.3	3.5	86.9	112.8	86.1	77.7	84.7	90.8	94.7	102.2	106.5	101.3	90.9	18.1	78.1	117.2	133.1	106.5	109.9	51.3	54.1	52.8	22.5	16.5	10.6	0.0	27.6	29.2	44.0	19.6	26.2			
			Gross Irri. Req. GIR	lit/s/ha		0.78	0.81	0.74	0.94	0.88	0.89	0.04	1.01	1.19	0.66	0.59	0.64	1.05	1.10	1.08	1.23	1.17	1.05	0.21	0.90	1.23	1.54	1.23	1.16	0.59	0.63	0.61	0.26	0.19	0.11	0.00	0.32	0.34	0.51	0.23	0.28			
Monthly Ave.			Gross Irri. Req. GIR	lit/s/ha			0.78			0.90			0.76			0.63			1.08			1.15			0.79			1.31			0.61			0.18			0.22			0.34		0.729	0.728 lit/s/ha	
Area			36,500 ha				28.5 m^3/s			32.9 m^3/s			27.7 m^3/s			23.0 m^3/s			39.4 m^3/s			42.0 m^3/s			28.8 m^3/s			47.8 m^3/s			22.3 m^3/s			6.6 m^3/s			8.0 m^3/s			12.4 m^3/s			26.6 m^3/s	

Table F.15 Irrigation Water Requirement, Kone, 2020, Average Rainfall Year

Kone River Basin **(using data in Quy Nhon, Future Cropping Pattern (2020))**

No.	Year	No.	Crop	Cropping Area (ha)	Area Ratio	Jan. 1	Jan. 2	Jan. 3	Feb. 1	Feb. 2	Feb. 3	Mar. 1	Mar. 2	Mar. 3	Apr. 1	Apr. 2	Apr. 3	May 1	May 2	May 3	Jun. 1	Jun. 2	Jun. 3	Jul. 1	Jul. 2	Jul. 3	Aug. 1	Aug. 2	Aug. 3	Sep. 1	Sep. 2	Sep. 3	Oct. 1	Oct. 2	Oct. 3	Nov. 1	Nov. 2	Nov. 3	Dec. 1	Dec. 2	Dec. 3	Total (mm/period)	Gross Requirement Depth (mm/year)	Gross Requirement Volume (m3/year/ha)
			Potential Evapotranspiration (ETo)	mm/month			105			110			141			159			176			182			191			184			152			124			103			96		1,723		
			Potential Evapotranspiration (ETo)	mm/10-day		35	35	35	37	37	36	47	47	47	53	53	53	58	58	60	61	61	60	63	63	65	61	61	62	51	51	50	41	41	42	34	34	35	32	32	32	1,723		
			Effective Rainfall (Pe)			17	17	19	11	11	10	8	8	8	13	13	13	20	20	21	18	18	17	16	16	15	17	17	19	49	49	49	57	57	57	56	56	56	41	41	41	971		
A	**Winter - Spring Crops**																																											
	Ave.	**1.**	**Paddy**	**40,000**	**0.82**																																							
		a	**Land Preparation (60 mm)**																																	**20.0**	**20.0**	**20.0**				60		
			Area (A %)																																	*33*	*67*							
		b	Evaporation (ETo*1.1*A%)																																	12.3	25.8					38		
		c	Percolation (2mm/day*A%)																																	6.6	13.4					20		
		d	Total Land Preparation Req. (a+b+c)																																	38.9	59.2	20.0				118		
			Crop Coefficient (kc)			*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																										*1.05*	*1.11*	*1.20*			
		e	**Crop Water Req. (CWR)**			**45.5**	**46.9**	**47.3**	**48.5**	**44.4**	**36.7**	**0.0**																										**33.6**	**35.5**	**38.4**	**377**		
		f	Percolation (2mm/day)			20.0	20.0	22.0	20.0	20.0	16.0	0.0																										20.0	20.0	22.0	180		
		g	Consumptive Use (CUW) (d+e+f)			65.5	66.9	69.3	68.5	64.4	52.7	0.0																								38.9	59.2	73.6	55.5	60.4	675		
		h	Effective Rainfall (Pe*A% or Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0																								18.5	37.5	41.0	41.0	41.0	272		
		i	Net Irri. Req. (NIR) mm/10-day			48.5	49.9	50.3	57.5	53.4	42.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5	21.7	32.6	14.5	19.4	411	587	**5,870**
		2.	**Upland Crops**	**3,000**	**0.06**																																							
			Crop Coefficient (kc) (Tomato)			*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*																							*0.35*	*0.38*	*0.45*			
			Crop Water Req. (CWR)			**20.3**	**25.9**	**30.8**	**37.0**	**40.0**	**38.9**	**49.4**	**44.7**	**30.1**	**13.3**																							**11.2**	**12.2**	**14.4**	**368**		
			Effective rainfall (Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0	8.0	8.0	13.0																							41.0	41.0	41.0	245		
			Net Irri. Req. (NIR) mm/10-day			3.3	8.9	11.8	26.0	29.0	28.9	41.4	36.7	22.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	208	297	**2,974**
B	**Summer - Autumn Crops**																																											
	Ave.	**1.**	**Paddy**	**28,000**	**0.57**																																							
		a	**Land Preparation (150 mm)**										**50.0**	**50.0**	**50.0**																											150		
			Area (A %)										*33*	*67*																														
		b	Evaporation (ETo*1.1*A%)										17.1	34.6																														
		c	Percolation (2mm/day*A%)										6.6	14.7																														
		d	Total Land Preparation Req. (a+b+c)										73.7	99.4	50.0																													
			Crop Coefficient (kc)												*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*																				
		e	**Crop Water Req. (CWR)**												**55.7**	**58.8**	**63.6**	**75.4**	**77.7**	**81.0**	**79.9**	**73.2**	**61.2**	**0.0**																		**627**		
		f	Percolation (2mm/day)												20.0	20.0	20.0	20.0	20.0	22.0	20.0	20.0	20.0	0.0																		182		
		g	Consumptive Use (CUW) (d+e+f)										73.7	99.4	85.7	78.8	83.6	95.4	97.7	103.0	99.9	93.2	81.2	0.0																		1032		
		h	Effective Rainfall (Pe*A% or Pe)										2.6	5.4	13.0	13.0	13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0																		177		
		i	Net Irri. Req. (NIR) mm/10-day			0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.0	94.0	72.7	65.8	70.6	75.4	77.7	82.0	81.9	75.2	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	758	1,083	**10,827**
		2.	**Upland Crops**	**15,000**	**0.31**																																							
			Crop Coefficient (kc) (Tomato)														*0.35*	*0.38*	*0.45*	*0.58*	*0.74*	*0.88*	*1.00*	*1.08*	*1.08*	*1.05*	*0.95*	*0.64*	*0.25*														
			Crop Water Req. (CWR)														**18.6**	**22.0**	**26.1**	**34.8**	**45.1**	**53.7**	**60.0**	**68.0**	**68.0**	**68.3**	**58.0**	**39.0**	**15.5**													**577**		
			Effective rainfall (Pe)														13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0	16.0	15.0	17.0	17.0	19.0													227		
			Net Irri. Req. (NIR) mm/10-day			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	2.0	6.1	13.8	27.1	35.7	43.0	52.0	52.0	53.3	41.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	354	505	**5,052**
C	**Rainy Season Crops**																																											
	Ave.	**1.**	**Paddy**	**40,000**	**0.82**																																							
		a	**Land Preparation (60 mm)**																						**20.0**	**20.0**	20.00															60		
			Area (A %)																						*33*	**67.00**																		
		b	Evaporation (ETo*1.1*A%)																						22.9	47.9																		
		c	Percolation (2mm/day*A%)																						6.6	14.7																		
		d	Total Land Preparation Req. (a+b+c)																						49.5	82.6	20.00																	
			Crop Coefficient (kc)																								*1.05*	*1.11*	*1.20*	*1.30*	*1.34*	*1.35*	*1.31*	*1.20*	*1.02*	*0.90*								
		e	**Crop Water Req. (CWR)**																								**64.1**	**67.7**	**74.4**	**66.3**	**68.3**	**67.5**	**53.7**	**49.2**	**42.8**	**0.0**						**554**		
		f	Percolation (2mm/day)																								20.0	20.0	22.0	20.0	20.0	20.0	20.0	20.0	22.0	0.0						184		
		g	Consumptive Use (CUW) (d+e+f)																						49.5	82.6	104.1	87.7	96.4	86.3	88.3	87.5	73.7	69.2	64.8	0.0						890		
		h	Effective Rainfall (Pe*A% or Pe)																						5.3	10.1	17.0	17.0	19.0	49.0	49.0	49.0	57.0	57.0	57.0	56.0						442		
		i	Net Irri. Req. (NIR) mm/10-day			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.2	72.6	87.1	70.7	77.4	37.3	39.3	38.5	16.7	12.2	7.8	0.0	0.0	0.0	0.0	0.0	0.0	504	720	**7,198**
		2.	**Upland Crops**	**0**	**0.00**																																							
			Crop Coefficient (kc) (Tomato)																																									
			Crop Water Req. (CWR)																																							**0**		
			Effective rainfall (Pe)																																							0		
			Net Irri. Req. (NIR) mm/10-day			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	-
D	**Year Round Crop**																																											
	Ave.	**1.**	**Upland Crops**	**6,000**	**0.12**																																							
			Crop Coefficient (kc) (Sugar Cane)			*0.97*	*0.92*	*0.85*	*0.78*	*0.71*	*0.60*	*0.55*	*0.50*	*0.50*	*0.50*	*0.50*	*0.00*	*0.55*	*0.57*	*0.65*	*0.75*	*0.85*	*0.95*	*1.00*	*1.05*	*1.08*	*1.11*	*1.14*	*1.15*	*1.15*	*1.16*	*1.15*	*1.15*	*1.14*	*1.13*	*1.12*	*1.10*	*1.08*	*1.06*	*1.03*	*1.00*			
			Crop Water Req. (CWR)			**34.0**	**32.2**	**29.8**	**28.9**	**26.3**	**21.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.9**	**33.1**	**39.0**	**45.8**	**51.9**	**57.0**	**63.0**	**66.2**	**70.2**	**67.7**	**69.5**	**71.3**	**58.7**	**59.2**	**57.5**	**47.2**	**46.7**	**47.5**	**38.1**	**37.4**	**37.8**	**33.9**	**33.0**	**32.0**	**1368**		
			Effective rainfall (Pe)			17.0	17.0	19.0	11.0	11.0	10.0	8.0	8.0	8.0	13.0	13.0	13.0	20.0	20.0	21.0	18.0	18.0	17.0	16.0	16.0	15.0	17.0	17.0	19.0	49.0	49.0	49.0	57.0	57.0	57.0	56.0	56.0	56.0	41.0	41.0	41.0	971		
			Net Irri. Req. (NIR) mm/10-day			17.0	15.2	10.8	17.9	15.3	11.6	0.0	0.0	0.0	0.0	0.0	0.0	11.9	13.1	18.0	27.8	33.9	40.0	47.0	50.2	55.2	50.7	52.5	52.3	9.7	10.2	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	568	812	**8,120**
				132,000	2.69																																							
			Weighted Ave. NIR Total	**49,000**	**1.00**	41.9	43.1	43.1	50.7	47.2	38.1	2.5	42.8	55.1	41.4	37.6	42.0	45.2	47.9	53.3	58.5	58.0	54.8	21.7	58.1	82.3	89.8	70.9	69.6	31.6	33.4	32.5	13.6	10.0	6.4	0.0	16.7	17.7	26.6	11.9	15.8		**1,958**	**19,577**
			Gross Irri. Req. GIR mm/10-day Irri. Efficiency		**0.70**	59.8	61.6	61.5	72.4	67.5	54.4	3.6	61.2	78.7	59.2	53.7	60.1	64.5	68.4	76.1	83.6	82.9	78.2	31.0	83.1	117.6	128.3	101.3	99.4	45.2	47.7	46.4	19.5	14.2	9.1	0.0	23.9	25.3	38.0	16.9	22.6			
			Gross Irri. Req. GIR lit/s/ha			0.69	0.71	0.65	0.84	0.78	0.79	0.04	0.71	0.83	0.47	0.40	0.45	0.75	0.79	0.80	0.97	0.96	0.91	0.36	0.96	1.24	1.48	1.17	1.05	0.52	0.55	0.54	0.23	0.16	0.10	0.00	0.28	0.29	0.44	0.20	0.24			
Monthly Ave.			Gross Irri. Req. GIR lit/s/ha				0.68			0.80			0.54			0.44			0.78			0.95			0.87			1.23			0.54			0.16			0.19			0.29		0.623	0.621 lit/s/ha	
Area			49,000 ha				33.3 m^3/s			39.2 m^3/s			26.5 m^3/s			21.6 m^3/s			38.2 m^3/s			46.6 m^3/s			42.6 m^3/s			60.3 m^3/s			26.5 m^3/s			7.8 m^3/s			9.3 m^3/s			14.2 m^3/s			30.4 m^3/s	

Table F.16 Present Water Demand for Livestock, 2001

River Basin	Kind of Livestock	Unit Water Requirement (lit/head/day)	Number (10^3 heads)	Daily Consumption (m^3/day)	Intake Discharge (m^3/sec)
01. Bang Giang and Ky Cung	Pig	15	332	4,983	0.058
	Ox	35	103	3,622	0.042
	Buffalo	35	166	5,822	0.067
	Poultry	0.25	2,625	656	0.008
	Goat	25	-	-	-
	Total	-		15,083	**0.175**
02. Red and Thai Binh	Pig	15	9,082	136,226	1.577
	Ox	35	991	34.690	0.402
	Buffalo	35	1,473	51,561	0.597
	Poultry	0.25	84,035	21,009	0.243
	Goat	25	-	-	-
	Total	-		243,486	**2.818**
03. Ma	Pig	15	1,494	22,410	0.259
	Ox	35	336	11,774	0.136
	Buffalo	35	368	12,895	0.149
	Poultry	0.25	11,180	2,795	0.032
	Goat	25	-	-	-
	Total	-		49,875	**0.577**
04. Ca	Pig	15	951	14,263	0.165
	Ox	35	353	12,354	0.143
	Buffalo	35	292	10,220	0.118
	Poultry	0.25	7,760	1,940	0.022
	Goat	25	-	-	-
	Total	-		38,777	**0.449**
05. Thach Han	Pig	15	186	2,784	0.032
	Ox	35	63	2,195	0.025
	Buffalo	35	35	1,239	0.014
	Poultry	0.25	1,700	425	0.005
	Goat	25	-	-	-
	Total	-		6,643	**0.077**
06. Huong	Pig	15	227	3,404	0.039
	Ox	35	33	1,149	0.013
	Buffalo	35	35	1,212	0.014
	Poultry	0.25	1,790	448	0.005
	Goat	25	-	-	-
	Total	-		6,212	**0.072**
07. Vu Gia - Thu Bon	Pig	15	495	7,425	0.086
	Ox	35	214	7,492	0.087
	Buffalo	35	52	1,822	0.021
	Poultry	0.25	3,910	978	0.011
	Goat	25	-	-	-
	Total	-		17,717	0.205
08. Tra Khuc	Pig	15	314	4,716	0.055
	Ox	35	174	6,101	0.071
	Buffalo	35	34	1,186	0.014
	Poultry	0.25	1,935	484	0.006
	Goat	25	-	-	-
	Total	-		12,487	**0.145**
09. Kone	Pig	15	221	3,310	0.038
	Ox	35	134	4,380	0.54
	Buffalo	35	10	354	0.004
	Poultry	0.25	1,800	450	0.005
	Goat	25	-	-	-
	Total	-		8,794	**0.102**
10. Ba	Pig	15	390	5852	0.068
	Ox	35	291	10,171	0.118
	Buffalo	35	17	586	0.007
	Poultry	0.25	2,075	519	0.006
	Goat	25	-	-	-
	Total	-		17,128	**0.198**
11. Sesan	Pig	15	190	2,846	0.033
	Ox	35	135	4,732	0.055
	Buffalo	35	14	503	0.006
	Poultry	0.25	780	195	0.002
	Goat	25	-	-	-
	Total	-		8,275	**0.096**
12. Srepok	Pig	15	299	4,480	0.052
	Ox	35	74	2,594	0.030
	Buffalo	35	16	550	0.006
	Poultry	0.25	2050	513	0.006
	Goat	25	-	-	-
	Total	-		8,136	**0.094**
13. Dong Nai	Pig	15	1,675	25,169	0.291
	Ox	35	313	10,964	0.127
	Buffalo	35	140	4,895	0.057
	Poultry	0.25	19,980	4,995	0.058
	Goat	25	-	-	-
	Total	-		46,023	**0.533**
14. Cuu Long Delta	Pig	15	2,662	39,937	0.462
	Ox	35	171	5,999	0.069
	Buffalo	35	41	1,429	0.017
	Poultry	0.25	38,960	9,740	0.113
	Goat	25	-	-	-
	Total	-		57,105	**0.661**

Table F.17 Future Water Demand for Livestock, 2010

River Basin	Kind of Livestock	Unit Water Requirement (lit/head/day)	Number (10^3 heads)	Daily Consumption (m^3/day)	Intake Discharge (m^3/sec)
01. Bang Giang and Ky Cung	Pig	15	558	8,363	0.097
	Ox	35	177	6,209	0.072
	Buffalo	35	355	12,411	0.144
	Poultry	0.25	-	-	-
	Goat	25	-	-	-
	Total	-		26,983	**0.312**
02. Red and Thai Binh	Pig	15	13,663	204,948	2.372
	Ox	35	1,363	47,689	0.552
	Buffalo	35	1,889	66,105	0.765
	Poultry	0.25	122,957	30,739	0.356
	Goat	25	30	750	0.009
	Total	-		350,231	**4.054**
03. Ma	Pig	15	2,187	32,805	0.380
	Ox	35	492	17,203	0.199
	Buffalo	35	482	16,863	0.195
	Poultry	0.25	4,105	1,026	0.012
	Goat	25	-	-	-
	Total	-	-	67,897	**0.786**
04. Ca	Pig	15	1,248	18,720	0.217
	Ox	35	480	16,800	0.194
	Buffalo	35	345	12,068	0.140
	Poultry	0.25	14,438	3,610	0.042
	Goat	25	-	-	-
	Total	-		51,198	**0.593**
05. Thach Han	Pig	15	240	3,600	0.042
	Ox	35	85	2,975	0.034
	Buffalo	35	42	1,470	0.017
	Poultry	0.25	-	-	-
	Goat	25	-	-	-
	Total	-		8,405	**0.093**
06. Huong	Pig	15	305	4,575	0.053
	Ox	35	49	1,698	0.020
	Buffalo	35	38	1,339	0.015
	Poultry	0.25	2,261	565	0.007
	Goat	25	-	-	-
	Total	-		8,177	**0.095**
07. Vu Gia - Thu Bon	Pig	15	533	7,995	0.093
	Ox	35	279	9,748	0.113
	Buffalo	35	65	2,279	0.026
	Poultry	0.25	4,080	1,020	0.012
	Goat	25	-	-	-
	Total	-		21,041	**0.244**
08. Tra Khuc	Pig	15	436	6,540	0.076
	Ox	35	223	7,805	0.090
	Buffalo	35	44	1,531	0.018
	Poultry	0.25	90	23	0.000
	Goat	25	-	-	-
	Total	-		15,899	**0.184**
09. Kone	Pig	15	361	5,420	0.063
	Ox	35	195	6,825	0.079
	Buffalo	35	11	389	0.004
	Poultry	0.25	3,764	941	0.011
	Goat	25	5	125	0.001
	Total	-		21,580	**0.250**
10. Ba	Pig	15	443	6,644	0.077
	Ox	35	390	13,650	0.158
	Buffalo	35	21	746	0.009
	Poultry	0.25	2,165	541	0.006
	Goat	25	-	-	-
	Total	-		13,699	**0.159**
11. Sesan	Pig	15	268	4,017	0.046
	Ox	35	254	8,890	0.103
	Buffalo	35	27	931	0.011
	Poultry	0.25	1,350	338	0.004
	Goat	25	-	-	-
	Total	-		14,176	**0.164**
12. Srepok	Pig	15	453	6,798	0.079
	Ox	35	188	6,577	0.076
	Buffalo	35	23	788	0.009
	Poultry	0.25	3,116	779	0.009
	Goat	25	-	-	-
	Total	-		14,941	**0.173**
13. Dong Nai	Pig	15	2,657	39,849	0.461
	Ox	35	490	17,133	0.198
	Buffalo	35	143	5,021	0.058
	Poultry	0.25	38,340	9,585	0.111
	Goat	25	-	-	-
	Total	-		71,588	**0.829**
14. Cuu Long Delta	Pig	15	5,236	78,537	0.909
	Ox	35	270	9,437	0.109
	Buffalo	35	49	1,706	0.020
	Poultry	0.25	69,417	17,354	0.201
	Goat	25	-	-	-
	Total	-		107,035	**1.239**

Table F.18 Future Water Demand for Livestock, 2020

River Basin	Kind of Livestock	Unit Water Requirement (lit/head/day)	Number (10^3 heads)	Daily Consumption (m^3/day)	Intake Discharge (m^3/sec)
01. Bang Giang and Ky Cung	Pig	15	780	11,701	0.135
	Ox	35	307	10,738	0.124
	Buffalo	35	465	16,291	0.189
	Poultry	0.25	-	-	-
	Goat	25	-	-	-
	Total	-		38,730	**0.448**
02. Red and Thai Binh	Pig	15	20,986	314,795	3.643
	Ox	35	1,997	69,895	0.809
	Buffalo	35	2,401	84,026	0.973
	Poultry	0.25	241,124	60,281	0.698
	Goat	25	43	1,075	0.012
	Total	-		530,073	**6.135**
03. Ma	Pig	15	3,222	48,333	0.559
	Ox	35	719	25,151	0.291
	Buffalo	35	626	21,896	0.253
	Poultry	0.25	10,979	2,745	0.032
	Goat	25	-	-	-
	Total	-		98,125	**1.136**
04. Ca	Pig	15	1,648	24,720	0.286
	Ox	35	649	22,708	0.263
	Buffalo	35	409	14,308	0.166
	Poultry	0.25	41,550	10,388	0.120
	Goat	25	-	-	-
	Total	-		72,124	**0.835**
05. Thach Han	Pig	15	402	6,030	0.070
	Ox	35	1118	4,130	0.048
	Buffalo	35	50	1,750	0.020
	Poultry	0.25	-	-	-
	Goat	25	-	-	-
	Total	-		11,910	**0.138**
06. Huong	Pig	15	666	9,997	0.116
	Ox	35	68	2,373	0.028
	Buffalo	35	42	1,470	0.017
	Poultry	0.25	2,872	718	0.008
	Goat	25	-	-	-
	Total	-		14,558	**0.168**
07. Vu Gia - Thu Bon	Pig	15	625	9,368	0.108
	Ox	35	356	12,460	0.144
	Buffalo	35	82	2,860	0.033
	Poultry	0.25	4,780	1,195	0.014
	Goat	25	-	-	-
	Total	-		25,883	**0.300**
08. Tra Khuc	Pig	15	673	10,098	0.117
	Ox	35	302	10,586	0.123
	Buffalo	35	59	2,058	0.024
	Poultry	0.25	150	37	0.000
	Goat	25	-	-	-
	Total	-		22,779	**0.264**
09. Kone	Pig	15	608	9,121	0.106
	Ox	35	298	10,442	0.121
	Buffalo	35	12	417	0.005
	Poultry	0.25	8,135	2,034	0.024
	Goat	25	10	250	0.003
	Total	-		22,263	**0.258**
10. Ba	Pig	15	615	9,227	0.107
	Ox	35	715	25,009	0.289
	Buffalo	35	28	994	0.012
	Poultry	0.25	4,432	1,108	0.013
	Goat	25	-	-	-
	Total	-		36,339	**0.421**
11. Sesan	Pig	15	385	5,774	0.067
	Ox	35	436	15,250	0.176
	Buffalo	35	47	1,638	0.019
	Poultry	0.25	2,444	611	0.007
	Goat	25	-	-	-
	Total	-		23,272	**0.269**
12. Srepok	Pig	15	747	11,201	0.130
	Ox	35	448	15,680	0.181
	Buffalo	35	31	1,068	0.012
	Poultry	0.25	7,418	1,854	0.021
	Goat	25	-	-	-
	Total	-		29,803	**0.345**
13. Dong Nai	Pig	15	4,721	70,814	0.820
	Ox	35	821	28,742	0.333
	Buffalo	35	154	5,390	0.062
	Poultry	0.25	72,960	18,240	0.211
	Goat	25	-	-	-
	Total	-		123,186	**1.426**
14. Cuu Long Delta	Pig	15	10,677	160,157	1.854
	Ox	35	455	15,908	0.184
	Buffalo	35	47	1,635	0.019
	Poultry	0.25	131,980	32,995	0.382
	Goat	25	-	-	-
	Total	-		210,693	**2.439**

Table F.19 Present Water Demand for Aquaculture, 2001 (1/2)

River Basin	Provinces concerned	Contribution to Basin	Coastal Shrimp Culture			Inland Fish Culture			Total Fresh Water Consumption (m^3/year)	Average Intake Discharge (m^3/sec)
			Provincial Shrimp Area (ha)	Shrimp Area in Basin (ha)	Fresh Water Consumption (m^3/year)	Provincial Fish Area (ha)	Fish Area in Basin (ha)	Fresh Water Consumption (m^3/year)		
01. Bang Giang										
	11. Cao Bang	65%	-	-	-	185	120	4,088,500	4,088,500	0.130
	14. Lang Son	70%	-	-	-	630	441	14,994,000	14,994,000	0.475
	13. Bac Kan	40%	-	-	-	370	148	5,032,000	5,032,000	0.160
	Subtotal			-	-		709	24,114,500	24,114,500	0.765
02. Red										
	01. Ha Noi	100%		-	-	2,900	2,900	98,600,000	98,600,000	3.127
	02. Hai Phong	100%	3,700	3,700	17,020,000	6,900	6,900	234,600,000	251,620,000	7.979
	19. Vinh Phuc	100%	-	-	-	2,410	2,410	81,940,000	81,940,000	2.598
	03. Ha Tay	100%	3	3	13,800	7,000	7,000	238,000,000	238,013,800	7.547
	21. Bac Ninh	100%	-	-	-	2,765	2,765	94,010,000	94,010,000	2.981
	04. Hai Duong	100%		-	-	5,800	5,800	197,200,000	197,200,000	6.253
	05. Hung Yen	100%	-	-	-	3,300	3,300	112,200,000	112,200,000	3.558
	06. Ha Nam	100%	-	-	-	3,800	3,800	129,200,000	129,200,000	4.097
	07. Nam Dinh	100%	2,100	2,100	9,660,000	6,800	6,800	231,200,000	240,860,000	7.638
	08. Thai Binh	100%	2,245	2,245	10,327,000	5,780	5,780	196,520,000	206,847,000	6.559
	09. Ninh Binh	100%	850	850	3,910,000	2,850	2,850	96,900,000	100,810,000	3.197
	10. Ha Giang	100%	-	-	-	900	900	30,600,000	30,600,000	0.970
	12. Lao Cai	100%	-	-	-	662	662	22,508,000	22,508,000	0.714
	13. Bac Kan	60%	-	-	-	370	222	7,548,000	7,548,000	0.239
	15. Tuyen Quang	100%	-	-	-	1,100	1,100	37,400,000	37,400,000	1.186
	16. Yen Bai	100%	-	-	-	1,700	1,700	57,800,000	57,800,000	1.833
	17. Thai Nguyen	100%	-	-	-	4,470	4,470	151,980,000	151,980,000	4.819
	18. Phu Tho	100%	-	-	-	3,177	3,177	108,018,000	108,018,000	3.425
	20. Bac Giang	100%	-	-	-	3,289	3,289	111,826,000	111,826,000	3.546
	22. Quang Ninh	100%	780	780	3,588,000	12,150	12,150	413,100,000	416,688,000	13.213
	23. Lai Chau	80%	-	-	-	1,000	800	27,200,000	27,200,000	0.863
	24. Son La	60%	-	-	-	945	567	19,278,000	19,278,000	0.611
	25. Hoa Binh	80%	-	-	-	1,300	1,040	35,360,000	35,360,000	1.121
	11. Cao Bang	35%	-	-	-	185	65	2,201,500	2,201,500	0.070
	14. Lang Son	30%	-	-	-	630	189	6,426,000	6,426,000	0.204
	Subtotal			9,678	44,518,800		80,636	2,741,615,500	2,786,134,300	88.348
03. Ma										
	26. Thanh Hoa	100%	4,550	4,550	20,930,000	8,600	8,600	292,400,000	313,330,000	9.936
	23. Lai Chau	20%	-	-	-	1,000	200	6,800,000	6,800,000	0.216
	24. Son La	40%	-	-	-	945	378	12,852,000	12,852,000	0.408
	25. Hoa Binh	20%	-	-	-	1,300	260	8,840,000	8,840,000	0.280
	27. Nghe An	20%	1,150	230	1,058,000	8,945	1,789	60,826,000	61,884,000	1.962
	Subtotal			4,780	21,988,000		11,227	381,718,000	403,706,000	12.801
04. Ca										
	27. Nghe An	80%	1,150	920	4,232,000	8,945	7,156	243,304,000	247,536,000	7.849
	28. Ha Tinh	80%	1,050	840	3,864,000	1,400	1,120	38,080,000	41,944,000	1.330
	Subtotal			1,760	8,096,000.00		8,276	281,384,000	289,480,000	9.179
05. Thach Han										
	30. Quang Tri	100%	190	190	874,000	520	520	17,680,000	18,554,000	0.588
	Subtotal			190	874,000		520	17,680,000	18,554,000	0.588
06. Huong										
	31. Thua Thien - Hue	100%	950	950	4,370,000	750	750	25,500,000	29,870,000	0.947
	33. Quang Nam	5%	1,200	60	276,000	3,400	170	5,780,000	6,056,000	0.192
	Subtotal			1,010	4,646,000		920	31,280,000	35,926,000	1.139

Data sources: Table 4.21- Fishes-area under water by provinces and Table4.23 - Shrimp-area under water by provinces from Statistical Data of Vietnam Agriculture, Forestry and Fishery 1975-2000, General Statistical Office, Department of Agriculture, Forestry and Fishery)

Plan for aquaculture development in the 14. Cuu Long drafted by the Institute of Fishery Ecocnomics and Planning - Ministry of Fishery

TableF.19 Present Water Demand for Aquaculture, 2001 (2/2)

River Basin	Provinces concerned	Contribution to Basin	Coastal Shrimp Culture			Inland Fish Culture			Total Fresh Water Consumption (m^3/year)	Average Intake Discharge (m^3/sec)
			Provincial Shrimp Area (ha)	Shrimp Area in Basin (ha)	Fresh Water Consumption (m^3/year)	Provincial Fish Area (ha)	Fish Area in Basin (ha)	Fresh Water Consumption (m^3/year)		
07. Thu Bon										
	32. Da Nang	30%	150	45	207,000	530	159	5,406,000	5,613,000	0.178
	33. Quang Nam	95%	1,200	1,140	5,244,000	3,400	3,230	109,820,000	115,064,000	3.649
	38. Kon Tum	10%	-	-	-	420	42	1,428,000	1,428,000	0.045
	Subtotal			1,185	5,451,000		3,431	116,654,000	122,105,000	3.872
08. Tra Khuc										
	34. Quang Ngai	75%	500	375	1,725,000	30	23	765,000	2,490,000	0.079
	38. Kon Tum	10%	-	-	-	420	42	1,428,000	1,428,000	0.045
	Subtotal			375	1,725,000		65	2,193,000	3,918,000	0.124
09. Kone										
	35. Binh Dinh	50%	1,870	935	4,301,000	1,370	685	23,290,000	27,591,000	0.875
	39. Gia Lai	5%	-	-	-	85	4	144,500	144,500	0.005
	Subtotal			935	4,301,000		689	23,434,500	27,735,500	0.879
10. Ba										
	36. Phu Yen	45%	1,855	835	3,839,850	70	32	1,071,000	4,910,850	0.156
	39. Gia Lai	65%	-	-	-	85	55	1,878,500	1,878,500	0.060
	40. Dak Lak	20%	5	1	4,600	3,075	615	20,910,000	20,914,600	0.663
	Subtotal			836	3,844,450		702	23,859,500	27,703,950	0.878
11. Se Sang										
	38. Kon Tum	80%	-	-	-	420	336	11,424,000	11,424,000	0.362
	39. Gia Lai	30%	-	-	-	85	26	867,000	867,000	0.027
	Subtotal			-	-		362	12,291,000	12,291,000	0.39
12. Srepok										
	40. Dak Lak	50%	-	-	-	3,075	1,538	52,275,000	52,275,000	1.658
	42. Lam Dong	25%	-	-	-	1,200	300	10,200,000	10,200,000	0.323
	Subtotal			-	-		1,838	62,475,000	62,475,000	1.981
13. Dong Nai										
	41. Ho Chi Minh Cty	85%	900	765	3,519,000	700	595	20,230,000	23,749,000	0.753
	42. Lam Dong	75%	-	-	-	1,200	900	30,600,000	30,600,000	0.970
	44. Binh Phuoc	100%	-	-	-	340	340	11,560,000	11,560,000	0.367
	45. Tay Ninh	100%	-	-	-	510	510	17,340,000	17,340,000	0.550
	46. Binh Duong	100%	-	-	-	167	167	5,678,000	5,678,000	0.180
	47. Dong Nai	80%	650	520	2,392,000	25,500	20,400	693,600,000	695,992,000	22.070
	48. Binh Thuan	40%	280	112	515,200	450	180	6,120,000	6,635,200	0.210
	50. Long An	100%	3,990	3,990	18,354,000	1,900	1,900	64,600,000	82,954,000	2.630
	40. Dak Lak	10%	5	1	2,300	3,075	308	10,455,000	10,457,300	0.332
	53. Tien Giang	30%	3,995	1,199	5,513,100	5,640	1,692	57,528,000	63,041,100	1.999
	Subtotal			6,586	30,295,600		26,992	917,711,000	948,006,600	30.061
14. Cuu Long Delta										
	51. Dong Thap	100%	120	120	552,000	1,600	1,600	54,400,000	54,952,000	1.743
	52. An Giang	100%	10	10	46,000	950	950	32,300,000	32,346,000	1.026
	53. Tien Giang	70%	3,995	2,797	12,863,900	5,640	3,948	134,232,000	147,095,900	4.664
	54. Vinh Long	100%	50	50	230,000	1,150	1,150	39,100,000	39,330,000	1.247
	55. Ben Tre	100%	35,583	35,583	163,681,800	1,400	1,400	47,600,000	211,281,800	6.700
	56. Kien Giang	100%	21,410	21,410	98,486,000	13,000	13,000	442,000,000	540,486,000	17.139
	57. Can Tho	100%	240	240	1,104,000	11,960	11,960	406,640,000	407,744,000	12.929
	58. Tra Vinh	100%	25,400	25,400	116,840,000	15,000	15,000	510,000,000	626,840,000	19.877
	59. Soc Trang	100%	39,000	39,000	179,400,000	2,900	2,900	98,600,000	278,000,000	8.815
	60. Bac Lieu	100%	58,591	58,591	269,518,600	7,650	7,650	260,100,000	529,618,600	16.794
	61. Ca mau	100%	209,000	209,000	961,400,000	60,000	60,000	2,040,000,000	3,001,400,000	95.174
	Subtotal			392,201	1,804,122,300		119,558	4,064,972,000	5,869,094,300	186.108

Data sources: Table 4.21- Fishes-area under water by provinces and Table4.23 - Shrimp-area under water by provinces from Statistical Data of Vietnam Agriculture, Forestry and Fishery 1975-2000, General Statistical Office, Department of Agriculture, Forestry and Fishery)

Plan for aquaculture development in the 14. Cuu Long drafted by the Institute of Fishery Ecocnomics and Planning - Ministry of Fishery

Table F.20 Future Water Demand for Aquaculture, 2010 (1/2)

River Basin	Provinces concerned	Contribution to Basin	Coastal Shrimp Culture			Inland Fish Culture			Total Fresh Water Consumption (m^3/year)	Average Intake Discharge (m^3/sec)
			Provincial Shrimp Area (ha)	Shrimp Area in Basin (ha)	Fresh Water Consumption (m^3/year)	Provincial Fish Area (ha)	Fish Area in Basin (ha)	Fresh Water Consumption (m^3/year)		
01. Bang Giang										
	11. Cao Bang	65%		-	-	210	137	4,641,000	4,641,000	0.147
	14. Lang Son	70%		-	-	693	485	16,493,400	16,493,400	0.523
	13. Bac Kan	40%		-	-	728	291	9,900,800	9,900,800	0.314
	Subtotal			-	-		913	31,035,200	31,035,200	0.984
02. Red										
	01. Ha Noi	100%		-	-	3,897	3,897	132,498,000	132,498,000	4.201
	02. Hai Phong	100%	6,166	6,166	28,363,600	11,499	11,499	390,966,000	419,329,600	13.297
	19. Vinh Phuc	100%		-	-	1,357	1,357	46,138,000	46,138,000	1.463
	03. Ha Tay	100%	3	3	13,800	8,084	8,084	274,856,000	274,869,800	8.716
	21. Bac Ninh	100%		-	-	4,344	4,344	147,696,000	147,696,000	4.683
	04. Hai Duong	100%		-	-	13,481	13,481	458,354,000	458,354,000	14.534
	05. Hung Yen	100%		-	-	4,815	4,815	163,710,000	163,710,000	5.191
	06. Ha Nam	100%		-	-	4,181	4,181	142,154,000	142,154,000	4.508
	07. Nam Dinh	100%	2,520	2,520	11,592,000	8,160	8,160	277,440,000	289,032,000	9.165
	08. Thai Binh	100%	3,076	3,076	14,149,600	7,920	7,920	269,280,000	283,429,600	8.987
	09. Ninh Binh	100%	1,721	1,721	7,916,600	5,771	5,771	196,214,000	204,130,600	6.473
	10. Ha Giang	100%		-	-	990	990	33,660,000	33,660,000	1.067
	12. Lao Cai	100%		-	-	728	728	24,752,000	24,752,000	0.785
	13. Bac Kan	60%		-	-	728	437	14,851,200	14,851,200	0.471
	15. Tuyen Quang	100%		-	-	1,210	1,210	41,140,000	41,140,000	1.305
	16. Yen Bai	100%		-	-	1,783	1,783	60,622,000	60,622,000	1.922
	17. Thai Nguyen	100%		-	-	4,918	4,918	167,212,000	167,212,000	5.302
	18. Phu Tho	100%		-	-	3,496	3,496	118,864,000	118,864,000	3.769
	20. Bac Giang	100%		-	-	7,967	7,967	270,878,000	270,878,000	8.589
	22. Quang Ninh	100%	1,339	1,339	6,159,400	20,853	20,853	709,002,000	715,161,400	22.678
	23. Lai Chau	80%		-	-	1,172	938	31,878,400	31,878,400	1.011
	24. Son La	60%		-	-	2,901	1,741	59,180,400	59,180,400	1.877
	25. Hoa Binh	80%		-	-	1,430	1,144	38,896,000	38,896,000	1.233
	11. Cao Bang	35%		-	-	210	74	2,499,000	2,499,000	0.079
	14. Lang Son	30%		-	-	693	208	7,068,600	7,068,600	0.224
	Subtotal			14,825	68,195,000		119,994	4,079,809,600	4,148,004,600	131.532
03. Ma										
	26. Thanh Hoa	100%	5,021	5,021	23,096,600	9,490	9,490	322,660,000	345,756,600	10.964
	23. Lai Chau	20%		-	-	1,172	234	7,969,600	7,969,600	0.253
	24. Son La	40%		-	-	2,901	1,160	39,453,600	39,453,600	1.251
	25. Hoa Binh	20%		-	-	1,430	286	9,724,000	9,724,000	0.308
	27. Nghe An	20%		-	-	13,203	2,641	89,780,400	89,780,400	2.847
	Subtotal			5,021	23,096,600		13,811	469,587,600	492,684,200	15.623
04. Ca										
	27. Nghe An	80%	1,697	1,358	6,244,960	13,203	10,562	359,121,600	365,366,560	11.586
	28. Ha Tinh	80%	1,155	924	4,250,400	1,540	1,232	41,888,000	46,138,400	1.463
	Subtotal			2,282	10,495,360.00		11,794	401,009,600	411,504,960	13.049
05. Thach Han										
	30. Quang Tri	100%	267	267	1,228,200	732	732	24,888,000	26,116,200	0.828
	Subtotal			267	1,228,200		732	24,888,000	26,116,200	0.828
06. Huong										
	31. Thua Thien - Hue	100%	3,231	3,231	14,862,600	2,550	2,550	86,700,000	101,562,600	3.221
	33. Quang Nam	5%	1,234	62	283,820	3,496	175	5,943,200	6,227,020	0.197
	Subtotal			3,293	15,146,420		2,725	92,643,200	107,789,620	3.418

Note. After the Governmental Resolution No. 09 of June 15, 2000 regarding land use transition from paddy area into shrimp cultivated area, the planned area for shrimp culture in the 14. Cuu Long Delta has been adjusted, and the estimation of its water demand has also been adjusted in accordance with it.

Table F.20 Future Water Demand for Aquaculture, 2010 (2/2)

River Basin	Provinces concerned	Contribution to Basin	Coastal Shrimp Culture			Inland Fish Culture			Total Fresh Water Consumption (m^3/year)	Average Intake Discharge (m^3/sec)
			Provincial Shrimp Area (ha)	Shrimp Area in Basin (ha)	Fresh Water Consumption (m^3/year)	Provincial Fish Area (ha)	Fish Area in Basin (ha)	Fresh Water Consumption (m^3/year)		
07. Thu Bon										
	32. Da Nang	30%	177	53	244,260	625	188	6,375,000	6,619,260	0.210
	33. Quang Nam	95%	1,234	1,172	5,392,580	3,496	3,321	112,920,800	118,313,380	3.752
	38. Kon Tum	10%	-	-	-	462	46	1,570,800	1,570,800	0.050
	Subtotal			1,225	5,636,840		3,555	120,866,600	126,503,440	4.011
08. Tra Khuc										
	34. Quang Ngai	75%	550	413	1,897,500	33	25	841,500	2,739,000	0.087
	38. Kon Tum	10%	-	-	-	462	46	1,570,800	1,570,800	0.050
	Subtotal			413	1,897,500		71	2,412,300	4,309,800	0.137
09. Kone										
	35. Binh Dinh	50%	2,057	1,029	4,731,100	1,507	754	25,619,000	30,350,100	0.962
	39. Gia Lai	5%	-	-	-	94	5	159,800	159,800	0.005
	Subtotal			1,029	4,731,100		758	25,778,800	30,509,900	0.967
10. Ba										
	36. Phu Yen	45%	3,051	1,373	6,315,570	115	52	1,759,500	8,075,070	0.256
	39. Gia Lai	65%	-	-	-	94	61	2,810,600	2,810,600	0.089
	40. Dak Lak	20%	6	1	5,520	3,383	677	23,004,400	23,009,920	0.730
	Subtotal			1,374	6,321,090		789	27,574,500	33,895,590	1.075
11. Se Sang										
	38. Kon Tum	80%	-	-	-	462	370	12,566,400	12,566,400	0.398
	39. Gia Lai	30%	-	-	-	94	28	958,800	958,800	0.030
	Subtotal			-	-		398	13,525,200	13,525,200	0.43
12. Srepok										
	40. Dak Lak	50%	-	-	-	3,383	1,692	57,511,000	57,511,000	1.824
	42. Lam Dong	25%	-	-	-	1,320	330	11,220,000	11,220,000	0.356
	Subtotal			-	-		2,022	68,731,000	68,731,000	2.179
13. Dong Nai										
	41. Ho Chi Minh Cty	85%	1,223	1,040	4,781,930	951	808	27,483,900	32,265,830	1.023
	42. Lam Dong	75%	-	-	-	1,320	990	33,660,000	33,660,000	1.067
	44. Binh Phuoc	100%	-	-	-	374	374	12,716,000	12,716,000	0.403
	45. Tay Ninh	100%	-	-	-	811	811	27,574,000	27,574,000	0.874
	46. Binh Duong	100%	-	-	-	184	184	6,256,000	6,256,000	0.198
	47. Dong Nai	80%	500	400	1,840,000	26,500	21,200	720,800,000	722,640,000	22.915
	48. Binh Thuan	40%	308	123	566,720	495	198	6,732,000	7,298,720	0.231
	50. Long An	100%	5,100	5,100	23,460,000	4,500	4,500	153,000,000	176,460,000	5.596
	40. Dak Lak	10%	6	1	2,760	3,383	338	11,502,200	11,504,960	0.365
	53. Tien Giang	30%	3,755	1,127	5,181,900	5,500	1,650	56,100,000	61,281,900	1.943
	Subtotal			7,790	35,833,310		31,054	1,055,824,100	1,091,657,410	34.616
14. Cuu Long Delta										
	51. Dong Thap	100%	350	350	1,610,000	-	-	-	1,610,000	0.051
	52. An Giang	100%	130	130	598,000	15,000	15,000	510,000,000	510,598,000	16.191
	53. Tien Giang	70%	3,755	2,629	12,091,100	5,500	3,850	130,900,000	142,991,100	4.534
	54. Vinh Long	100%	55	55	253,000	12,600	12,600	428,400,000	428,653,000	13.592
	55. Ben Tre	100%	50,391	50,391	231,798,600	10,500	10,500	357,000,000	588,798,600	18.671
	56. Kien Giang	100%	51,967	51,967	239,048,200	40,300	40,300	1,370,200,000	1,609,248,200	51.029
	57. Can Tho	100%	4,000	4,000	18,400,000	44,000	44,000	1,496,000,000	1,514,400,000	48.021
	58. Tra Vinh	100%	13,400	13,400	61,640,000	36,006	36,006	1,224,187,000	1,285,827,000	40.773
	59. Soc Trang	100%	45,000	45,000	207,000,000	-	-	-	207,000,000	6.564
	60. Bac Lieu	100%	133,000	133,000	611,800,000	-	-	-	611,800,000	19.400
	61. Ca mau	100%	227,000	227,000	1,044,200,000	45,000	45,000	1,530,000,000	2,574,200,000	81.627
	Subtotal			527,922	2,428,438,900		207,256	7,046,687,000	9,475,125,900	300.454

Note. After the Governmental Resolution No. 09 of June 15, 2000 regarding land use transition from paddy area into shrimp cultivated area, the planned area for shrimp culture in the 14. Cuu Long Delta has been adjusted, and the estimation of its water demand has also been adjusted in accordance with it.

Table F.21 Future Water Demand for Aquaculture, 2020 (1/2)

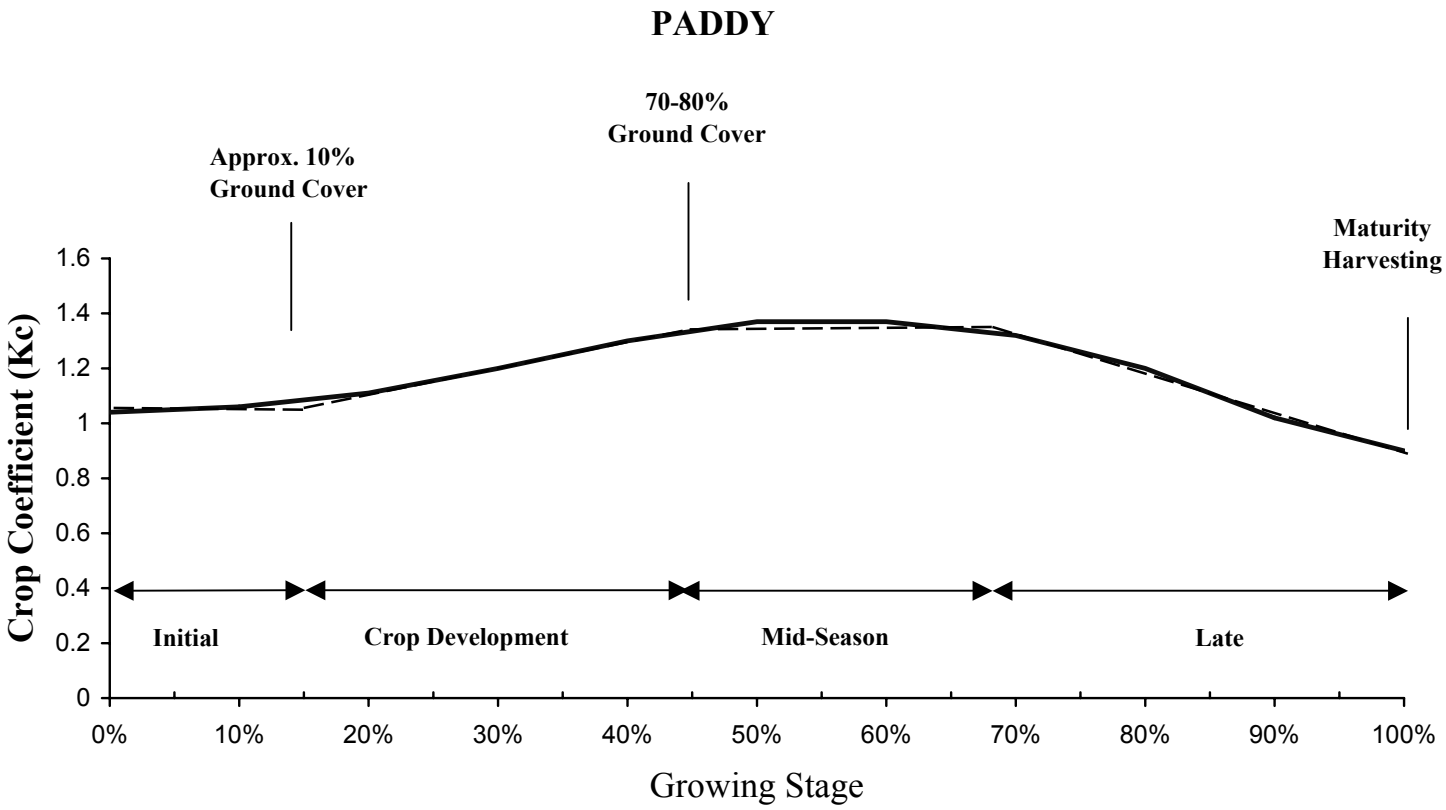
River Basin	Provinces concerned	Contribution to Basin	Coastal Shrimp Culture			Inland Fish Culture			Total Fresh Water Consumption (m^3/year)	Average Intake Discharge (m^3/sec)
			Provincial Shrimp Area (ha)	Shrimp Area in Basin (ha)	Fresh Water Consumption (m^3/year)	Provincial Fish Area (ha)	Fish Area in Basin (ha)	Fresh Water Consumption (m^3/year)		
01. Bang Giang										
	11. Cao Bang	65%	-	-	-	216	141	4,780,009	4,780,009	0.152
	14. Lang Son	70%	-	-	-	713	499	16,967,020	16,967,020	0.538
	13. Bac Kan	40%	-	-	-	790	316	10,749,848	10,749,848	0.341
	Subtotal			-	-		956	32,496,877	32,496,877	1.030
02. Red										
	01. Ha Noi	100%	-	-	-	4,232	4,232	143,903,640	143,903,640	4.563
	02. Hai Phong	100%	6,696	6,696	30,802,842	12,488	12,488	424,579,760	455,382,602	14.440
	19. Vinh Phuc	100%	-	-	-	1,474	1,474	50,113,960	50,113,960	1.589
	03. Ha Tay	100%	4	4	17,296	8,779	8,779	298,483,280	298,500,576	9.465
	21. Bac Ninh	100%	-	-	-	4,717	4,717	160,377,660	160,377,660	5.086
	04. Hai Duong	100%	-	-	-	14,640	14,640	497,758,300	497,758,300	15.784
	05. Hung Yen	100%	-	-	-	5,229	5,229	177,779,200	177,779,200	5.637
	06. Ha Nam	100%	-	-	-	4,540	4,540	154,375,640	154,375,640	4.895
	07. Nam Dinh	100%	2,737	2,737	12,588,774	8,862	8,862	301,296,780	313,885,554	9.953
	08. Thai Binh	100%	3,341	3,341	15,367,174	8,601	8,601	292,432,980	307,800,154	9.760
	09. Ninh Binh	100%	1,869	1,869	8,598,090	6,267	6,267	213,082,760	221,680,850	7.029
	10. Ha Giang	100%	-	-	-	1,075	1,075	36,562,580	36,562,580	1.159
	12. Lao Cai	100%	-	-	-	791	791	26,894,000	26,894,000	0.853
	13. Bac Kan	60%	-	-	-	790	474	16,124,772	16,124,772	0.511
	15. Tuyen Quang	100%	-	-	-	1,314	1,314	44,687,560	44,687,560	1.417
	16. Yen Bai	100%	-	-	-	1,937	1,937	65,848,480	65,848,480	2.088
	17. Thai Nguyen	100%	-	-	-	5,341	5,341	181,594,340	181,594,340	5.758
	18. Phu Tho	100%	-	-	-	3,796	3,796	129,066,040	129,066,040	4.093
	20. Bac Giang	100%	-	-	-	8,652	8,652	294,157,460	294,157,460	9.328
	22. Quang Ninh	100%	1,454	1,454	6,687,388	22,645	22,645	769,945,980	776,633,368	24.627
	23. Lai Chau	80%	-	-	-	1,273	1,018	34,620,160	34,620,160	1.098
	24. Son La	60%	-	-	-	3,151	1,890	64,271,832	64,271,832	2.038
	25. Hoa Binh	80%	-	-	-	1,553	1,243	42,250,032	42,250,032	1.340
	11. Cao Bang	35%	-	-	-	216	76	2,573,851	2,573,851	0.082
	14. Lang Son	30%	-	-	-	713	214	7,271,580	7,271,580	0.231
	Subtotal			16,100	74,061,564		130,296	4,430,052,627	4,504,114,191	142.825
03. Ma										
	26. Thanh Hoa	100%	5,147	5,147	23,674,912	9,728	9,728	330,747,580	354,422,492	11.239
	23. Lai Chau	20%	-	-	-	1,273	255	8,655,040	8,655,040	0.274
	24. Son La	40%	-	-	-	3,151	1,260	42,847,888	42,847,888	1.359
	25. Hoa Binh	20%	-	-	-	1,553	311	10,562,508	10,562,508	0.335
	27. Nghe An	20%	1,805	361	1,660,536	14,039	2,808	95,466,492	97,127,028	3.080
	Subtotal			5,508	25,335,448		14,361	488,279,508	513,614,956	16.287
04. Ca										
	27. Nghe An	80%	1,805	1,444	6,642,142	14,039	11,231	381,865,968	388,508,110	12.320
	28. Ha Tinh	80%	1,228	983	4,520,770	1,638	1,310	44,552,512	49,073,282	1.556
	Subtotal			2,427	11,162,912.00		12,542	426,418,480	437,581,392	13.876
05. Thach Han										
	30. Quang Tri	100%	292	292	1,341,820	798	798	27,143,560	28,485,380	0.903
	Subtotal			292	1,341,820		798	27,143,560	28,485,380	0.903
06. Huong										
	31. Thua Thien - Hue	100%	4,450	4,450	20,471,288	3,513	3,513	119,454,920	139,926,208	4.437
	33. Quang Nam	5%	1,264	63	290,821	3,583	179	6,090,369	6,381,190	0.202
	Subtotal			4,514	20,762,109		3,693	125,545,289	146,307,398	4.639

Note. After the Governmental Resolution No. 09 of June 15, 2000 regarding land use transition from paddy area into shrimp cultivated area, the planned area for shrimp culture in the 14. Cuu Long Delta has been adjusted, and the estimation of its water demand has also been adjusted in accordance with it.

Table F.21 Future Water Demand for Aquaculture, 2020 (2/2)

River Basin	Provinces concerned	Contribution to Basin	Coastal Shrimp Culture			Inland Fish Culture			Total Fresh Water Consumption (m^3/year)	Average Intake Discharge (m^3/sec)
			Provincial Shrimp Area (ha)	Shrimp Area in Basin (ha)	Fresh Water Consumption (m^3/year)	Provincial Fish Area (ha)	Fish Area in Basin (ha)	Fresh Water Consumption (m^3/year)		
07. Thu Bon										
	32. Da Nang	30%	181	54	250,304	641	192	6,536,976	6,787,280	0.215
	33. Quang Nam	95%	1,264	1,201	5,525,603	3,583	3,403	115,717,011	121,242,614	3.845
	38. Kon Tum	10%	-	-	-	473	47	1,609,288	1,609,288	0.051
	Subtotal			1,256	5,775,907		3,643	123,863,275	129,639,182	4.111
08. Tra Khuc										
	34. Quang Ngai	75%	605	454	2,087,250	34	25	862,155	2,949,405	0.094
	38. Kon Tum	10%	-	-	-	473	47	1,609,288	1,609,288	0.051
	Subtotal			454	2,087,250		73	2,471,443	4,558,693	0.145
09. Kone										
	35. Binh Dinh	50%	2,107	1,054	4,846,997	1,544	772	26,246,640	31,093,637	0.986
	39. Gia Lai	5%	-	-	-	101	5	171,445	171,445	0.005
	Subtotal			1,054	4,846,997		777	26,418,085	31,265,082	0.991
10. Ba										
	36. Phu Yen	45%	3,290	1,480	6,809,493	124	56	1,899,342	8,708,835	0.276
	39. Gia Lai	65%	-	-	-	101	66	2,228,785	2,228,785	0.071
	40. Dak Lak	20%	6	1	5,180	3,465	693	23,564,516	23,569,696	0.747
	Subtotal			1,481	6,814,672		814	27,692,643	34,507,315	1.094
11. Se Sang										
	38. Kon Tum	80%	-	-	-	473	379	12,874,304	12,874,304	0.408
	39. Gia Lai	30%	-	-	-	101	30	1,028,670	1,028,670	0.033
	Subtotal			-	-		409	13,902,974	13,902,974	0.44
12. Srepok										
	40. Dak Lak	50%	-	-	-	3,465	1,733	58,911,290	58,911,290	1.868
	42. Lam Dong	25%	-	-	-	1,411	353	11,996,135	11,996,135	0.380
	Subtotal			-	-		2,086	70,907,425	70,907,425	2.248
13. Dong Nai										
	41. Ho Chi Minh Cty	85%	1,307	1,111	5,109,471	1,016	864	29,373,382	34,482,853	1.093
	42. Lam Dong	75%	-	-	-	1,411	1,058	35,988,405	35,988,405	1.141
	44. Binh Phuoc	100%	-	-	-	400	400	13,595,580	13,595,580	0.431
	45. Tay Ninh	100%	-	-	-	867	867	29,480,720	29,480,720	0.935
	46. Binh Duong	100%	-	-	-	196	196	6,677,940	6,677,940	0.212
	47. Dong Nai	80%	534	428	1,966,813	28,327	22,661	770,483,792	772,450,605	24.494
	48. Binh Thuan	40%	329	132	605,930	529	212	7,197,664	7,803,594	0.247
	50. Long An	100%	5,452	5,452	25,077,084	4,810	4,810	163,544,760	188,621,844	5.981
	40. Dak Lak	10%	6	1	2,590	3,465	347	11,782,258	11,784,848	0.374
	53. Tien Giang	30%	4,819	1,446	6,650,137	7,058	2,118	71,995,374	78,645,511	2.494
	Subtotal			8,568	39,412,025		33,533	1,140,119,875	1,179,531,900	37.403
14. Cuu Long Delta										
	51. Dong Thap	100%	449	449	2,066,182	-	-	-	2,066,182	0.066
	52. An Giang	100%	167	167	767,464	19,250	19,250	654,503,060	655,270,524	20.778
	53. Tien Giang	70%	4,819	3,373	15,516,987	7,058	4,941	167,989,206	183,506,193	5.819
	54. Vinh Long	100%	71	71	324,760	16,170	16,170	549,782,720	550,107,480	17.444
	55. Ben Tre	100%	64,689	64,689	297,568,296	13,475	13,475	458,152,040	755,720,336	23.964
	56. Kien Giang	100%	66,691	66,691	306,779,980	51,719	51,719	1,758,431,720	2,065,211,700	65.487
	57. Can Tho	100%	5,133	5,133	23,613,456	56,467	56,467	1,919,875,960	1,943,489,416	61.628
	58. Tra Vinh	100%	17,197	17,197	79,105,050	46,207	46,207	1,571,047,520	1,650,152,570	52.326
	59. Soc Trang	100%	57,750	57,750	265,651,288	-	-	-	265,651,288	8.424
	60. Bac Lieu	100%	170,684	170,684	785,147,090	-	-	-	785,147,090	24.897
	61. Ca mau	100%	291,318	291,318	1,340,063,122	57,750	57,750	1,963,509,520	3,303,572,642	104.756
	Subtotal			677,523	3,116,603,675		265,979	9,043,291,746	12,159,895,421	385.588

Note. After the Governmental Resolution No. 09 of June 15, 2000 regarding land use transition from paddy area into shrimp cultivated area, the planned area for shrimp culture in the 14. Cuu Long Delta has been adjusted, and the estimation of its water demand has also been adjusted in accordance with it.



* Data Source: Final Report, Volume VII, Appendix VI - Agricultural Development and Irrigation, Dong Nai M/P (JICA, MARD, August 1996)

Figure F.1 (1/5) Crop Coeffient Curve (Paddy)

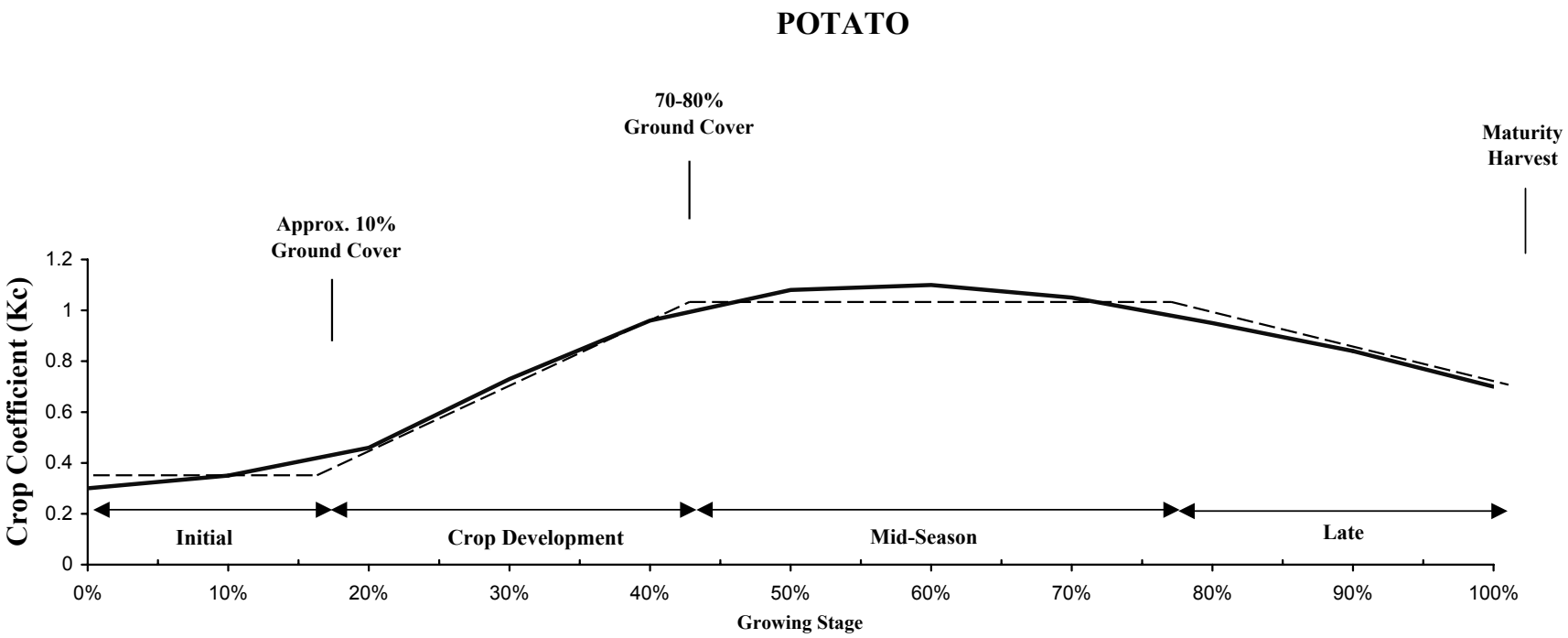


Figure F.1 (2/5) Crop Coeffient Curve (Potato)

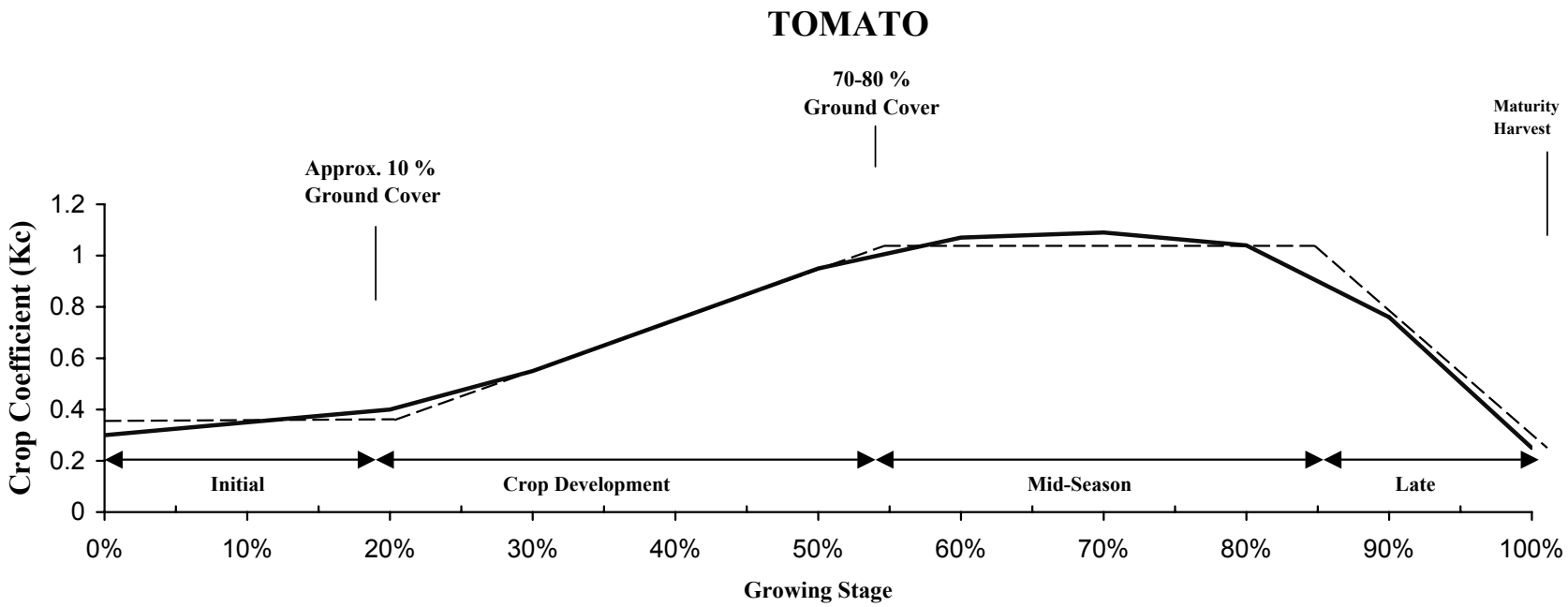


Figure F.1 (3/5) Crop Coeffient Curve (Tomato)

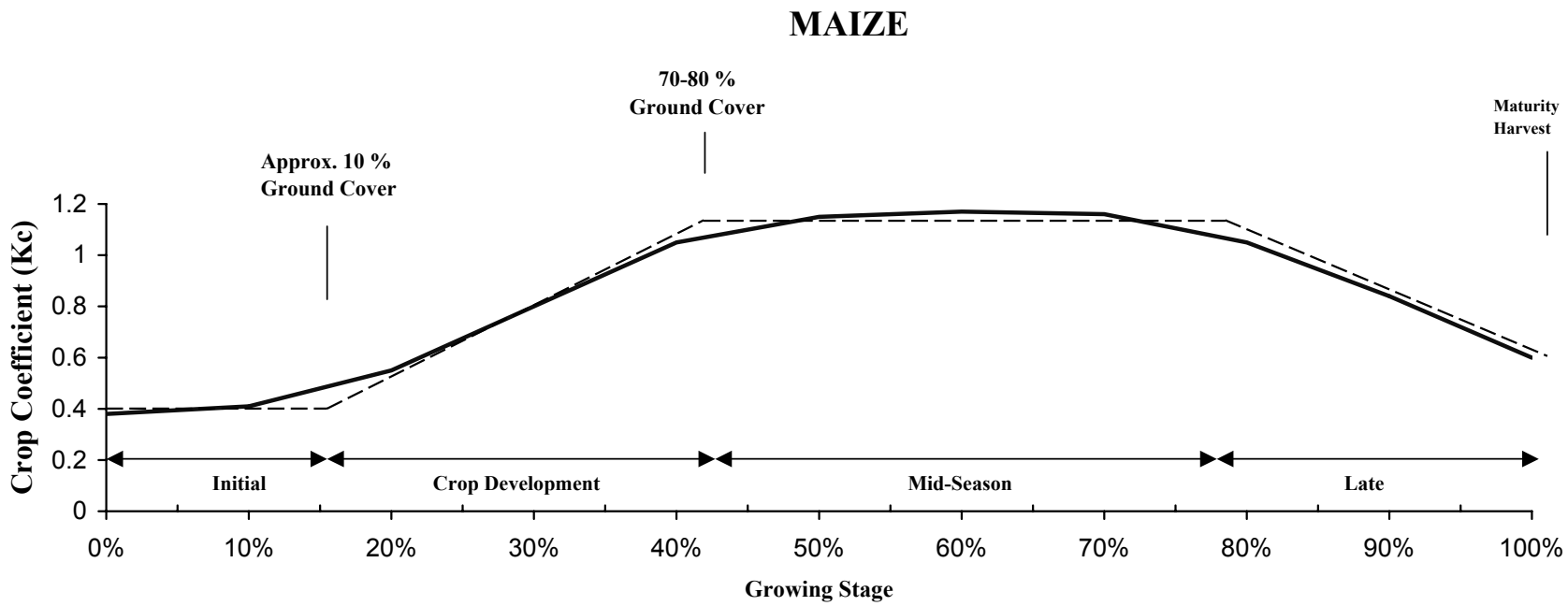


Figure F.1 (4/5) Crop Coeffient Curve (Maize)

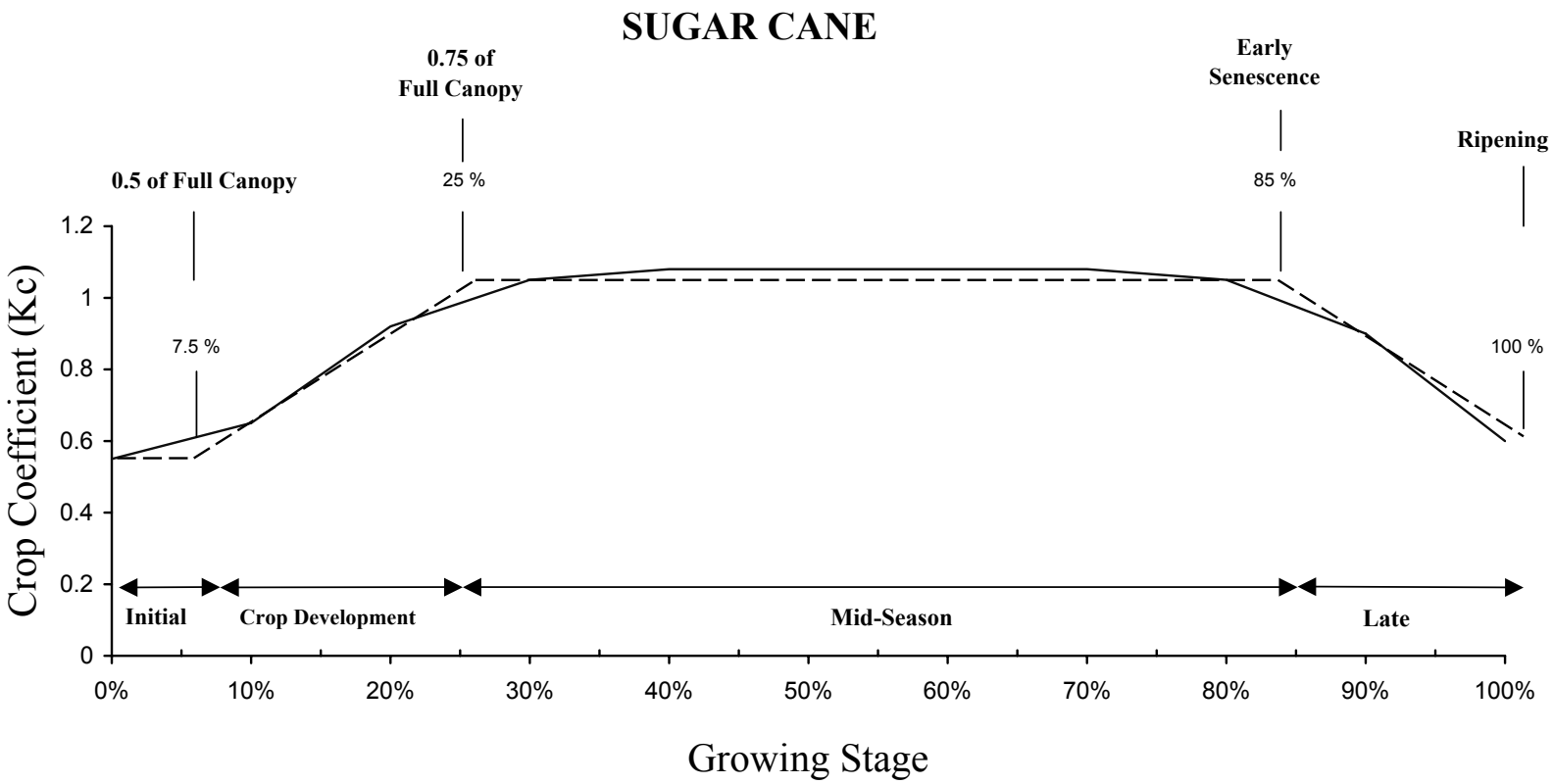
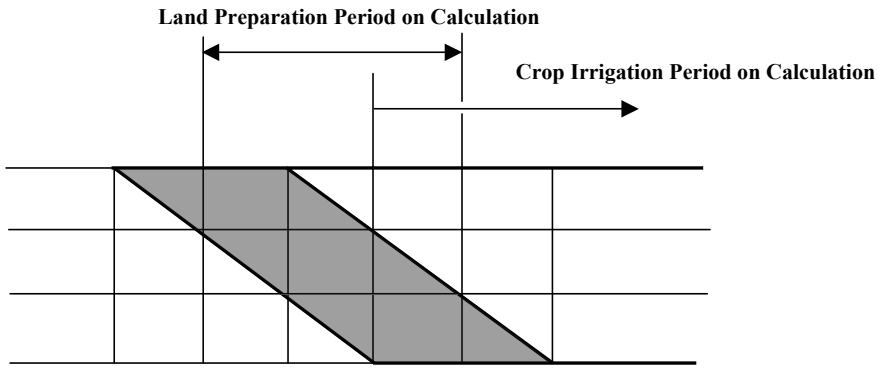


Figure F.1 (5/5) Crop Coeffient Curve (Sugar Cane)



Land Preparation Water Requirement

(1) Land Soaking and Standing Water

	Dry Time	Wet Time
Land Soaking	100 mm	10 mm
Standing Water	50 mm	50 mm
Total	150 mm	60 mm

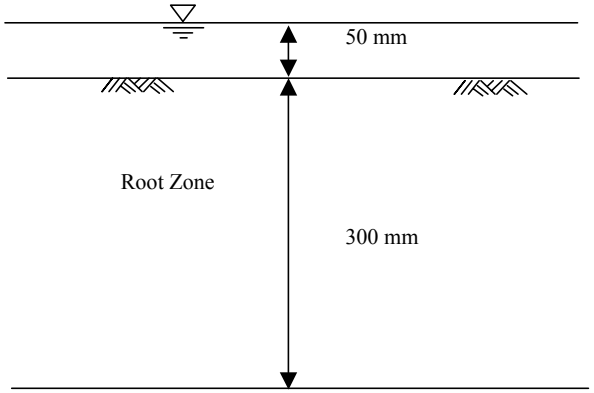
for 30 days

(2) Percolation

2 mm/day

(3) Evaporation from Water Surface

Ep = ETo x 1.1



Porosity : $\frac{100}{300}$ = 33 % for Dry Time

$\frac{10}{300}$ = 3% for Wet Time

Figure F.2 Land Preparation Water Requirement

ANNEX CALCULATION PROCESS OF IRRIGATION WATER DEMAND (IWD)

This Annex is for the purpose of supporting the main text describing the irrigation water demand for more concrete understanding. Calculations made in the process for estimation of irrigation water demand (IWD) are presented applying the data and condition of the Kone River Basin, for example.

1. CROPPING PATTERN IN IRRIGATED FIELD

1.1 Cultivated Land Area and Planted Area

The present and future cultivation areas and planted areas are presented in Section 4.4 in the main text. Those of the Kone River Basin are as follows:

(A) Present (2001)

Cultivated Land Area and Planted Area in Kone River Basin (Unit: ha)

Item	Cultivated Land Area	Planted Area
Paddy Field	44,000	120,000
Upland Crop Field	31,000	34,000
Total	75,000	154,000

(B) Future (2010, 2020)

Cultivated Land Area and Planted Area in Kone River Basin (Unit: ha)

Item	Cultivated Land Area		Planted Area	
	2010	2020	2010	2020
Paddy Field	40,000	40,000	120,000	120,000
Upland Crop Field	31,000	34,000	37,000	37,000
Total	71,000	74,000	157,000	157,000

1.2 Cropping Pattern

The present and future cropping patterns are presented in Section 4.4 in the main text. Those of the Kone River Basin are briefly explained below with planted areas. The planted areas presented below are composed of the irrigation area and the rainfed area.

(A) Present (2001)

Cropping Pattern covering both Irrigated and Rainfed Fields (Unit: ha)

Cropping Time	Paddy Rice	Upland Crops
Winter - Spring	44,000	3,000
Summer - Autumn	33,000	13,000
Rainy Season	33,000	-
Year Round	-	28,000
Total	110,000	44,000

(B) Future (2010, 2020)

Cropping Pattern covering both Irrigated and Rainfed Fields (Unit: ha)

Cropping Time	Paddy Rice		Upland Crops	
	2010	2020	2010	2020
Winter - Spring	40,000	40,000	3,000	3,000
Summer - Autumn	28,000	28,000	15,000	15,000
Rainy Season	40,000	40,000	-	-
Year Round	-	-	31,000	31,000
Total	108,000	108,000	49,000	49,000

1.3 Irrigation Area

Estimated irrigation areas at present and required irrigation areas in future are determined in Section 4.4 in the main text in consideration of the crop production plan. Those of the Kone River Basin are as shown below.

(A) Present (2001)

Irrigation Area in Kone River Basin (Unit: ha)

Item	Cultivated Land Area	Planted Area
Paddy Field	24,000	72,000
Upland Crop Field	1,000	1,500
Total	25,000	73,500

(B) Future (2010, 2020)

Irrigation Area in Kone River Basin (Unit: ha)

Item	Cultivated Land Area		Planted Area	
	2010	2020	2010	2020
Paddy Field	32,000	40,000	96,000	120,000
Upland Crop Field	4,500	9,000	6,500	12,000
Total	36,500	49,000	102,500	132,000

1.4 Cropping Pattern in Irrigated Field

The present and future cropping patterns in the irrigated field are determined in Section 4.4 in the main text. Those of the Kone River Basin are as follows:

(A) Present (2001)

Cropping Pattern in Irrigated Field (Unit: ha)

Cropping Time	Paddy Rice	Upland Crops
Winter - Spring	24,000	500
Summer - Autumn	24,000	500
Rainy Season	24,000	-
Year Round	-	500
Total	72,000	1,500

(B) Future (2010, 2020)

Cropping Pattern in Irrigated Field (Unit: ha)

Cropping Time	Paddy Rice		Upland Crops	
	2010	2020	2010	2020
Winter - Spring	32,000	40,000	2,000	3,000
Summer - Autumn	28,000	28,000	6,000	15,000
Rainy Season	32,000	40,000	-	-
Year Round	-	-	2,500	6,000
Total	92,000	108,000	10,500	24,000

2. CONSUMPTIVE USE OF WATER OF CROPS

2.1 Potential Evapotranspiration (ETo)

The monthly potential evapotranspirations (ETo mm/month) have been obtained from the Vietnam Hydrometeorological ATLAS, 1994 after checking by the Modified Penman Method is shown in Table F.1.

ETo in the Kone River Basin is as follows:

River Basin	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Kone (mm)	105	110	141	159	176	182	191	184	152	124	103	96	1,723
(%)	*3.4*	*3.9*	*4.5*	*5.3*	*5.7*	*6.1*	*6.2*	*5.9*	*5.1*	*4.1*	*3.3*	*3.1*	*100.0*

2.2 Crop Coefficient (Kc)

Kc values of the respective development stages determined are as follows:

Crop	Initial	Mid	Harvest
Rice	1.05	1.35	0.90
Upland Crops, Winter-Spring, Summer-Autumn, Rainy Season (Tomato)	0.35	1.05	0.25
Year Round Crops (Sugar Cane)	0.55	1.15	0.60

Crop coefficient curves drawn for the respective crops are shown in Figure F.1. Value of Kc at each growing time has been read on the curve.

2.3 Crop Water Requirement (CWR)

Crop water requirement (CWR) or crop evapotranspiration (ETc) of the concerned crops have been estimated based on the respective cropping patterns. Those of the Kone River Basin for the present and the future are described below.

(A) Present (2001)

Present crop water requirements (CWR) for the Kone River Basin estimated for the 1/4 drought year are compiled in Data Book.

Those for the average rainfall year are compiled in Data Book.

(B) Future (2010, 2020)

Future crop water requirements (CWR) of 2010 and 2020 estimated for the 1/4 drought year are compiled in Data Book.

Those for the average rainfall year are compiled in Data Book.

2.4 Consumptive Use of Water of Crops (CUW)

Consumptive uses of water of the various crops concerned for the 1/4 drought year and the average rainfall year are compiled in Data Book. As CUW is water requirement before deducting the effective rainfall, the values in 1/4 drought year and the average rainfall year are the same each other.

For example, the peak values of CUW of the respective crops based on the present (2001) cropping pattern are shown below.

As mentioned previously, the consumptive use of water (CUW) is defined as follows:

a) Consumptive use of water of paddy rice field (CUW)

$CUW = CWR + P$ for growing period

$CUW = LPW$ for land preparation period

where, CUW: Consumptive use of water (mm/10-day)
CWR: Crop water requirement (mm/10-day)
P: Percolation loss (mm/10-day)
LPW: Land preparation water requirement (mm/10-day) (see Figure F.2)

b) Consumptive use of water upland crops (CUW)

$CUW = CWR$

where, CUW: Consumptive use of water of crop (mm/10-day)
CWR: Crop water requirement (mm/10-day)

Peak Consumptive Use of Water (CUW), Kone, 2001 (Unit: mm/10-day)

Crop	Time	Peak CUW
Rice, Winter-Spring	Early Dec.	74
Rice, Summer-Autumn	Late May	103
Rice, Rainy Season	Early Aug.	104
Upland Crops, Winter-Spring (Tomato)	Early Mar.	49
Upland Crops, Summer-Autumn (Tomato)	Late July	68
Year Round Crops (Sugar Cane)	Late Aug.	71

3. UNIT IRRIGATION WATER REQUIREMENT

3.1 Effective Rainfall (Peff)

The monthly effective rainfalls (Peff mm/month) have been estimated with use of the monthly rainfall data (Ptot mm/month) in the respective river basins.

Ptot and Peff for the 25-year period of the Kone River Basin are shown in Table FA.1. The monthly Peff of the Kone River Basin in the 1/4 drought year are as follows:

Rainfall (Ptot) and Effective Rainfall (Peff) in 1/4 Drought Year 1988, Kone (Unit: mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Ptot	17	59	8	5	1	80	183	9	214	830	335	91	1,832
Peff	17	54	8	5	1	70	129	9	141	208	158	77	877
(%)	*100*	*92*	*100*	*100*	*100*	*88*	*70*	*100*	*66*	*25*	*47*	*85*	*48*

On the other hand, Peffs in the average rainfall year, which have been estimated with use of Ptots taken from the Vietnam Hydrometeorological ATLAS, 1994, are shown in Table FA.1. The monthly Peff of the Kone River Basin in the average year are as follows:

Rainfall (Ptot) and Effective Rainfall (Peff) in Average Year (with ATLAS's Data), Kone (Unit: mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Ptot	59	34	25	42	68	59	51	59	237	458	432	169	1,693
Peff	53	32	24	39	61	53	47	53	147	171	168	123	971
(%)	*90*	*94*	*96*	*93*	*90*	*90*	*92*	*90*	*62*	*37*	*39*	*73*	*57*

A balance calculation has been made between the above-mentioned CUW and Peff. In case Peff is larger than CUW, Peff has been adjusted to be equal to CUW.

The balance calculation process for the 1/4 drought year and the average rainfall year is compiled in Data Book.

3.2 Net Irrigation Water Requirement (NIR)

Net irrigation water requirements (NIR) of the respective crops concerned have been estimated based on the respective cropping patterns for the present (2001) and the future (2010, 2020).

It of the Kone River Basin for the 1/4 drought year and the average rainfall year is compiled in Data Book.

3.3 Gross Unit Irrigation Requirement (GIR)

Taking the irrigation efficiency (Ep) into the calculation, the gross unit irrigation water requirements GIR (mm/10-day) as well as GIR (l/sec/ha) have been estimated based on the respective cropping patterns for the present (2001) and the future (2010, 2020).

Those of the Kone River Basin for the 1/4 drought year and the average rainfall year are compiled in Data Book.

The peak values of 10-day basis GIR (l/sec/ha) for irrigation schemes in the Kone River Basin based on the condition of the 1/4 drought year are shown as below:

Peak Gross Unit Irrigation Water Requirement (GIR),

1/4 Drought Year 1988 (Unit: l/sec/ha)

River Basin	Cropping Pattern	Time	Peak GIR
Kone	2001	Early Aug.	1.91
	2010	Early Aug.	1.78
	2020	Early Aug.	1.70

The monthly gross unit irrigation water requirements GIR (l/sec/ha) for 25 years from 1976 to 2000 have been used for the water balance calculation.

The monthly GIRs (l/sec/ha) have been calculated with an average of the 10-day basis GIRs (l/sec/ha).

The monthly GIRs (l/sec/ha) for the 25 years for the present (2001) and future (2010, 2020) cropping patterns in the Kone River Basin are compiled in Data Book. The 1/4 drought year has been obtained through the water balance calculation.

The monthly GIRs (l/sec/ha) in the 1/4 drought year in the Kone River Basin have been calculated with an average of the 10-day basis GIRs (l/sec/ha) as follows:

Monthly Gross Unit Irrigation water Requirement (GIR),
Kone, 1/4 Drought Year 1988 (Unit: l/sec/ha)

Condition	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
2001	1.12	0.88	1.03	0.98	1.79	1.28	0.56	1.70	0.75	0.03	0.28	0.67	0.92
2010	0.98	0.76	0.78	0.74	1.42	1.05	0.63	1.55	0.65	0.02	0.24	0.57	0.78
2020	0.88	0.67	0.55	0.53	1.10	0.85	0.69	1.45	0.57	0.02	0.21	0.50	0.67

The above are compiled in Data Book.

On the other hand, the monthly GIRs (l/sec/ha) in the average rainfall year in the Kone River Basin have been calculated with an average of the 10-day basis GIRs (l/sec/ha) as follows:

Monthly Gross Unit Irrigation water Requirement (GIR),
Kone, Average Rainfall Year (Unit: l/sec/ha)

Condition	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
2001	0.90	1.04	1.00	0.84	1.41	1.39	0.74	1.43	0.71	0.22	0.26	0.40	0.86
2010	0.78	0.90	0.76	0.63	1.08	1.15	0.79	1.31	0.61	0.18	0.22	0.34	0.73
2020	0.68	0.80	0.54	0.44	0.78	0.95	0.87	1.23	0.54	0.16	0.19	0.29	0.62

The above are compiled in Data Book.

4. IRRIGATION WATER DEMAND

Taking the irrigation area into the calculation, the irrigation water demands IWD (m^3/sec) have been estimated for the present (2001) and the future (2010, 2020).

The IWDs (m^3/sec) in the Kone River Basin based on the present (2001) and future (2010, 2020) cropping patterns are shown as follows:

Monthly Irrigation Water Demand (IWD), 1/4 Drought Year 1988, Kone (Unit: m^3/sec)

Condition Irri. Area	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
2001 25,000 ha	28.0	22.0	25.8	24.5	44.8	32.0	14.0	42.5	18.8	0.8	7.0	16.8	23.1
2010 36,500 ha	35.8	27.7	28.5	27.0	51.8	38.3	23.0	56.6	23.7	0.7	8.8	20.8	28.6
2020 49,000 ha	43.1	32.8	27.0	26.0	53.9	41.7	33.8	71.1	27.9	1.0	10.3	24.5	32.8

The above are compiled in Data Book.

Monthly Irrigation Water Demand (IWD), Average Year, Kone (Unit: m^3/sec)

Condition Irri. Area	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
2001 25,000 ha	22.5	26.0	25.0	21.0	35.3	34.8	18.5	35.8	17.8	5.5	6.5	10.0	21.5
2010 36,500 ha	28.5	32.9	27.7	23.0	39.4	42.0	28.8	47.8	22.3	6.6	8.0	12.4	26.6
2020 49,000 ha	33.3	39.2	26.5	21.6	38.2	46.4	42.6	60.3	26.5	7.8	9.3	14.2	30.4

The above are compiled in Data Book.

Table FA.1 CALCULATION SHEET OF EFFECTIVE RAINFALL (ER10-day) (1/5)

River Bsin: Kone **Station: Phu Cat**

No.	Year	Item	Effective rainfall (ER10-day) (mm/10-day)																																			Total
			Jan.			Feb.			Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	(mm/year)
1.	**Ave.**	(Quy Nhon)																																					
		Monthly Rain (RAm) (mm/month)		59			34			25			42			68			59			51			59			237			458			432			169		1,693
		Monthly Effec. Rain (ERm) (mm/month)		**53**			**32**			**24**			**39**			**61**			**53**			**47**			**53**			**147**			**171**			**168**			**123**		**971**
		10-day Rain (RA10-day) (mm/10-day)	19	19	21	12	12	10	8	8	9	14	14	14	22	22	24	20	20	19	17	17	17	19	19	21	79	79	79	152	152	154	144	144	144	56	56	57	57%
		Ratio of RE10-day (ER10)	17	17	19	11	11	10	8	8	9	13	13	13	20	20	21	18	18	17	16	16	16	17	17	19	49	49	49	57	57	57	56	56	56	41	41	41	
		RE10-day (mm/10-day)	**17**	**17**	**19**	**11**	**11**	**10**	**8**	**8**	**8**	**13**	**13**	**13**	**20**	**20**	**21**	**18**	**18**	**17**	**16**	**16**	**15**	**17**	**17**	**19**	**49**	**49**	**49**	**57**	**57**	**57**	**56**	**56**	**56**	**41**	**41**	**41**	**971**
2.	**1976**																																						
		Monthly Rain (RAm) (mm/month)		59			34			25			42			68			32			37			241			249			417			495			96		1,795
		Monthly Effec. Rain (ERm) (mm/month)		**53**			**32**			**24**			**39**			**61**			**30**			**34**			**148**			**150**			**167**			**174**			**82**		**994**
		10-day Rain (RA10-day) (mm/10-day)	19	19	21	12	12	10	8	8	9	14	14	14	22	22	24	11	11	9.9	12	12	13	80	80	81	83	83	83	139	139	139	165	165	165	32	32	32	55%
		Ratio of RE10-day (ER10)	17	17	19	11	11	10	8	8	9	13	13	13	20	20	21	10	10	9	11	11	12	49	49	50	50	50	50	56	56	56	58	58	58	27	27	27	
		RE10-day (mm/10-day)	**17**	**17**	**19**	**11**	**11**	**10**	**8**	**8**	**8**	**13**	**13**	**13**	**20**	**20**	**21**	**10**	**10**	**10**	**11**	**11**	**12**	**49**	**49**	**50**	**50**	**50**	**50**	**56**	**56**	**55**	**58**	**58**	**58**	**27**	**27**	**28**	**994**
3.	**1977**																																						
		Monthly Rain (RAm) (mm/month)		32			0			17			0			2.3			23			69			65			604			286			576			42		1,715
		Monthly Effec. Rain (ERm) (mm/month)		**31**			**0**			**16**			**0**			**2**			**22**			**61**			**58**			**185**			**154**			**183**			**39**		**751**
		10-day Rain (RA10-day) (mm/10-day)	10	10	12	0	0	0	5	5	6.7	0	0	0	0	0	2.3	7	7	9	23	23	23	21	21	23	201	201	202	95	95	96	191	191	194	13	13	16	44%
		Ratio of RE10-day (ER10)	10	10	12	0	0	0	5	5	6	0	0	0	0	0	2	7	7	9	20	20	20	19	19	21	62	62	62	51	51	51	61	61	61	12	12	14	
		RE10-day (mm/10-day)	**10**	**10**	**11**	**0**	**0**	**0**	**5**	**5**	**6**	**0**	**0**	**0**	**0**	**0**	**2**	**7**	**7**	**8**	**20**	**20**	**21**	**19**	19	20	62	**62**	**61**	**51**	**51**	**52**	**61**	**61**	**61**	**12**	**12**	**15**	**751**
4.	**1978**																																						
		Monthly Rain (RAm) (mm/month)		171			16			0			20			182			75			203			143			282			611			257			44		2,003
		Monthly Effec. Rain (ERm) (mm/month)		**124**			**16**			**0**			**19**			**129**			**66**			**137**			**110**			**153**			**186**			**151**			**41**		**1,132**
		10-day Rain (RA10-day) (mm/10-day)	56	56	59	5	5	6	0	0	0	6	6	7.5	60	60	62	24	24	27	67	67	69	47	47	49	94	94	94	203	203	205	85	85	87	14	14	16	57%
		Ratio of RE10-day (ER10)	41	41	42	5	5	6	0	0	0	6	6	7	43	43	44	21	21	23	45	45	46	36	36	37	51	51	51	62	62	62	50	50	50	13	13	15	
		RE10-day (mm/10-day)	**41**	**41**	**42**	**5**	**5**	**6**	**0**	**0**	**0**	**6**	**6**	**7**	**43**	**43**	**43**	**21**	**21**	**24**	**45**	**45**	**47**	**36**	**36**	**38**	**51**	**51**	**51**	**62**	**62**	**62**	**50**	**50**	**51**	**13**	**13**	**15**	**1132**
5.	**1979**																																						
		Monthly Rain (RAm) (mm/month)		0			0			0			1.4			58			104			5			64			199			465			245			84		1,225
		Monthly Effec. Rain (ERm) (mm/month)		**0**			**0**			**0**			**1**			**52**			**87**			**5**			**57**			**136**			**171**			**149**			**73**		**731**
		10-day Rain (RA10-day) (mm/10-day)	0	0	0	0	0	0	0	0	0	0	0	1.4	19	19	20	34	34	36	1	1	3	21	21	22	66	66	67	154	154	157	81	81	83	28	28	28	60%
		Ratio of RE10-day (ER10)	0	0	0	0	0	0	0	0	0	0	0	1	17	17	18	28	28	30	1	1	3	19	19	20	45	45	45	57	57	57	50	50	50	24	24	25	
		RE10-day (mm/10-day)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**17**	**17**	**18**	**28**	**28**	**31**	**1**	**1**	**3**	**19**	**19**	**19**	**45**	**45**	**46**	**57**	**57**	**57**	**50**	**50**	**49**	**24**	**24**	**25**	**731**
6.	**1980**																																						
		Monthly Rain (RAm) (mm/month)		4			1			0			9			178			147			55			83			165			827			421			39		1,930
		Monthly Effec. Rain (ERm) (mm/month)		**4**			**1**			**0**			**9**			**127**			**112**			**50**			**72**			**122**			**208**			**167**			**37**		**909**
		10-day Rain (RA10-day) (mm/10-day)	1	1	2	0	0	1	0	0	0	3	3	3	59	59	60	48	48	51	18	18	19	27	27	29	55	55	55	275	275	277	140	140	141	13	13	13	47%
		Ratio of RE10-day (ER10)	1	1	2	0	0	1	0	0	0	3	3	3	42	42	43	37	37	38	16	16	17	24	24	25	40	40	41	69	69	69	56	56	56	12	12	13	
		RE10-day (mm/10-day)	**1**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**3**	**3**	**42**	**42**	**43**	**37**	**37**	**38**	**16**	**16**	**18**	**24**	**24**	**24**	**40**	**40**	**42**	**69**	**69**	**70**	**56**	**56**	**55**	**12**	**12**	**13**	**909**

Table FA.1 CALCULATION SHEET OF EFFECTIVE RAINFALL (ER10-day) (2/5)

River Bsin: Kone **Station: Phu Cat**

No.	Year	Item		Effective rainfall (ER10-day) (mm/10-day)																																	Total
				Jan.			Feb.			Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	(mm/year)
7.	**1981**																																				
		Monthly Rain (RAm)	(mm/month)		0			0			0			45			13			138			79			14			186			1026			1021			212		2,733
		Monthly Effec. Rain (ERm)	(mm/month)		**0**			**0**			**0**			**42**			**13**			**107**			**69**			**14**			**130**			**228**			**227**			**140**		**970**
		10-day Rain (RA10-day)	(mm/10-day)	0	0	0	0	0	0	0	0	0	15	15	15	4	4	5	45	45	48	26	26	27	4	4	6	61	61	64	341	341	344	340	340	341	70	70	72	35%
		Ratio of RE10-day (ER10)		0	0	0	0	0	0	0	0	0	14	14	14	4	4	5	35	35	37	23	23	23	4	4	6	43	43	44	76	76	76	76	76	76	46	46	47	
		RE10-day	(mm/10-day)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**14**	**14**	**14**	**4**	**4**	**5**	**35**	**35**	**37**	**23**	**23**	**23**	**4**	**4**	**6**	**43**	**43**	**44**	**76**	**76**	**76**	**76**	**76**	**75**	**46**	**46**	**48**	**970**
8.	**1982**																																				
		Monthly Rain (RAm)	(mm/month)		4.6			0.4			1.4			16			19			78			20			37			205			226			227			54		888
		Monthly Effec. Rain (ERm)	(mm/month)		**5**			**0**			**1**			**16**			**18**			**68**			**19**			**35**			**138**			**144**			**145**			**49**		**638**
		10-day Rain (RA10-day)	(mm/10-day)	1	1	2.6	0	0	0.4	0	0	1.4	5	5	6	6	6	6.5	26	26	26	6	6	7.5	12	12	13	68	68	69	75	75	76	75	75	77	17	17	20	72%
		Ratio of RE10-day (ER10)		1	1	3	0	0	0	0	0	1	5	5	6	6	6	6	23	23	23	6	6	7	11	11	12	46	46	46	48	48	48	48	48	49	16	16	18	
		RE10-day	(mm/10-day)	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**1**	**5**	**5**	**6**	**6**	**6**	**6**	**23**	**23**	**22**	**6**	**6**	**7**	**11**	**11**	**13**	**46**	**46**	**46**	**48**	**48**	**48**	**48**	**48**	**49**	**16**	**16**	**17**	**638**
9.	**1983**																																				
		Monthly Rain (RAm)	(mm/month)		30			0			2.1			3.8			41			126			46			192			210			801			481			115		2,049
		Monthly Effec. Rain (ERm)	(mm/month)		**29**			**0**			**2**			**4**			**38**			**101**			**43**			**133**			**139**			**205**			**173**			**94**		**961**
		10-day Rain (RA10-day)	(mm/10-day)	10	10	10	0	0	0	0	0	2.1	1	1	1.8	13	13	15	42	42	42	15	15	16	63	63	66	70	70	70	267	267	267	160	160	161	38	38	39	47%
		Ratio of RE10-day (ER10)		10	10	10	0	0	0	0	0	2	1	1	2	12	12	14	34	34	34	14	14	15	44	44	45	46	46	47	68	68	68	58	58	58	31	31	32	
		RE10-day	(mm/10-day)	**10**	**10**	**9**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**	**2**	**12**	**12**	**14**	**34**	**34**	**33**	**14**	**14**	**15**	**44**	**44**	**45**	**46**	**46**	**47**	**68**	**68**	**69**	**58**	**58**	**57**	**31**	**31**	**32**	**961**
10.	**1984**																																				
		Monthly Rain (RAm)	(mm/month)		38			0.5			0			29			127			325			50			5			101			525			712			137		2,050
		Monthly Effec. Rain (ERm)	(mm/month)		**36**			**0**			**0**			**28**			**101**			**157**			**46**			**5**			**85**			**178**			**196**			**107**		**939**
		10-day Rain (RA10-day)	(mm/10-day)	12	12	14	0	0	0.5	0	0	0	9	9	11	42	42	43	108	108	109	16	16	18	1	1	3	33	33	35	175	175	175	237	237	238	45	45	47	46%
		Ratio of RE10-day (ER10)		11	11	13	0	0	0	0	0	0	9	9	11	34	34	34	52	52	53	15	15	16	1	1	3	28	28	29	59	59	59	65	65	66	35	35	36	
		RE10-day	(mm/10-day)	**11**	**11**	**14**	**0**	**0**	**0**	**0**	**0**	**0**	**9**	**9**	**10**	**34**	**34**	**33**	**52**	**52**	**53**	**15**	**15**	**16**	**1**	**1**	**3**	**28**	**28**	**29**	**59**	**59**	**60**	**65**	**65**	**66**	**35**	**35**	**37**	**939**
11.	**1985**																																				
		Monthly Rain (RAm)	(mm/month)		27			6.6			0			55			106			80			69			17			329			434			816			179		2,117
		Monthly Effec. Rain (ERm)	(mm/month)		**25**			**7**			**0**			**50**			**88**			**70**			**61**			**17**			**158**			**168**			**207**			**128**		**979**
		10-day Rain (RA10-day)	(mm/10-day)	8	8	11	2	2	2.6	0	0	0	18	18	19	35	35	36	26	26	28	22	22	25	5	5	7	109	109	111	144	144	146	272	272	272	59	59	61	46%
		Ratio of RE10-day (ER10)		8	8	10	2	2	3	0	0	0	16	16	17	29	29	30	23	23	24	20	20	22	5	5	7	53	53	53	56	56	56	69	69	69	42	42	43	
		RE10-day	(mm/10-day)	**8**	**8**	**9**	**2**	**2**	**3**	**0**	**0**	**0**	**16**	**16**	**18**	**29**	**29**	**30**	**23**	**23**	**24**	**20**	**20**	**21**	**5**	**5**	**7**	**53**	**53**	**52**	**56**	**56**	**56**	**69**	**69**	**69**	**42**	**42**	**44**	**979**
12.	**1986**																																				
		Monthly Rain (RAm)	(mm/month)		7			40			1			0			124			25			16			51			106			658			152			443		1,621
		Monthly Effec. Rain (ERm)	(mm/month)		**7**			**37**			**1**			**0**			**99**			**24**			**15**			**47**			**88**			**191**			**115**			**169**		**793**
		10-day Rain (RA10-day)	(mm/10-day)	2	2	3	13	13	14	0	0	1	0	0	0	41	41	42	8	8	8.5	5	5	5.5	17	17	17	35	35	36	219	219	220	50	50	52	147	147	149	49%
		Ratio of RE10-day (ER10)		2	2	3	12	12	13	0	0	1	0	0	0	33	33	33	8	8	8	5	5	5	16	16	16	29	29	29	64	64	64	38	38	39	56	56	57	
		RE10-day	(mm/10-day)	**2**	**2**	**3**	**12**	**12**	**13**	**0**	**0**	**1**	**0**	**0**	**0**	**33**	**33**	**33**	**8**	**8**	**8**	**5**	**5**	**5**	**16**	**16**	**15**	**29**	**29**	**30**	**64**	**64**	**63**	**38**	**38**	**39**	**56**	**56**	**57**	**793**

Table FA.1 CALCULATION SHEET OF EFFECTIVE RAINFALL (ER10-day) (3/5)

River Bsin: Kone **Station: Phu Cat**

No.	Year	Item		Effective rainfall (ER10-day) (mm/10-day)																																			Total
				Jan.			Feb.			Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	(mm/year)
13.	**1987**																																							
		Monthly Rain (RAm)	(mm/month)		2			14			0			0			62			50			101			66			134			144			1047			75			1,694
		Monthly Effec. Rain (ERm)	(mm/month)		**2**			**14**			**0**			**0**			**56**			**46**			**85**			**59**			**105**			**111**			**230**			**66**			**774**
		10-day Rain (RA10-day)	(mm/10-day)	0	0	2	4	4	6	0	0	0	0	0	0	20	20	22	16	16	18	33	33	35	22	22	22	44	44	46	47	47	50	349	349	349	24	24	27	46%
		Ratio of RE10-day (ER10)		0	0	2	4	4	6	0	0	0	0	0	0	18	18	20	15	15	16	28	28	29	20	20	20	35	35	36	36	36	38	77	77	77	21	21	23	
		RE10-day	(mm/10-day)	**0**	**0**	**2**	**4**	**4**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**18**	**18**	**20**	**15**	**15**	**16**	**28**	**28**	**29**	**20**	**20**	**19**	**35**	**35**	**35**	**36**	**36**	**39**	**77**	**77**	**76**	**21**	**21**	**24**	**774**
14.	**1988**																																							
		Monthly Rain (RAm)	(mm/month)		17.6			59.5			8.0			5.0			1.5			80			183			9.0			214			830			335			91			1,832
		Monthly Effec. Rain (ERm)	(mm/month)		**17**			**54**			**8**			**5**			**1**			**70**			**129**			**9**			**141**			**208**			**158**			**77**			**877**
		10-day Rain (RA10-day)	(mm/10-day)	5	5	7.6	19	19	22	2	2	4	1	1	3	0	0	1.5	26	26	28	60	60	63	3	3	3	71	71	72	276	276	278	111	111	113	30	30	31	48%
		Ratio of RE10-day (ER10)		5	5	7	17	17	19	2	2	4	1	1	3	0	0	1	23	23	24	43	43	44	3	3	3	47	47	47	69	69	69	53	53	53	26	26	26	
		RE10-day	(mm/10-day)	**5**	**5**	**7**	**17**	**17**	**20**	**2**	**2**	**4**	**1**	**1**	**3**	**0**	**0**	**1**	**23**	**23**	**24**	**43**	**43**	**43**	**3**	**3**	**3**	**47**	**47**	**47**	**69**	**69**	**70**	**53**	**53**	**52**	**26**	**26**	**25**	**877**
15.	**1989**																																							
		Monthly Rain (RAm)	(mm/month)		49			3.5			268			1			99			109			87			316			21			192			29.1			7.5			1,181
		Monthly Effec. Rain (ERm)	(mm/month)		**45**			**3**			**152**			**1**			**83**			**90**			**75**			**157**			**20**			**133**			**28**			**7**			**794**
		10-day Rain (RA10-day)	(mm/10-day)	16	16	17	1	1	1.5	89	89	90	0	0	1	32	32	35	36	36	37	29	29	29	105	105	106	6	6	8.6	64	64	64	9	9	11	2	2	3.5	67%
		Ratio of RE10-day (ER10)		15	15	16	1	1	1	51	51	51	0	0	1	27	27	29	30	30	30	25	25	25	52	52	52	6	6	8	44	44	44	9	9	11	2	2	3	
		RE10-day	(mm/10-day)	**15**	**15**	**15**	**1**	**1**	**1**	**51**	**51**	**50**	**0**	**0**	**1**	**27**	**27**	**29**	**30**	**30**	**30**	**25**	**25**	**25**	**52**	**52**	**53**	**6**	**6**	**8**	**44**	**44**	**45**	**9**	**9**	**10**	**2**	**2**	**3**	**794**
16.	**1990**																																							
		Monthly Rain (RAm)	(mm/month)		8.1			0			20			151			209			371			17			94			158			1005			385			169			2,585
		Monthly Effec. Rain (ERm)	(mm/month)		**8**			**0**			**19**			**115**			**139**			**162**			**16**			**80**			**118**			**226**			**163**			**123**			**1169**
		10-day Rain (RA10-day)	(mm/10-day)	2	2	4.1	0	0	0	6	6	7.5	50	50	51	69	69	71	123	123	125	5	5	6.8	31	31	32	52	52	54	335	335	335	128	128	129	56	56	57	45%
		Ratio of RE10-day (ER10)		2	2	4	0	0	0	6	6	7	38	38	39	46	46	47	54	54	54	5	5	7	26	26	27	39	39	40	75	75	75	54	54	55	41	41	41	
		RE10-day	(mm/10-day)	**2**	**2**	**4**	**0**	**0**	**0**	**6**	**6**	**7**	**38**	**38**	**39**	**46**	**46**	**47**	**54**	**54**	**54**	**5**	**5**	**6**	**26**	**26**	**28**	**39**	**39**	**40**	**75**	**75**	**76**	**54**	**54**	**55**	**41**	**41**	**41**	**1169**
17.	**1991**																																							
		Monthly Rain (RAm)	(mm/month)		59			55			80			57			26			103			66			23			230			514			175			105			1,491
		Monthly Effec. Rain (ERm)	(mm/month)		**53**			**50**			**70**			**51**			**25**			**86**			**59**			**22**			**145**			**176**			**126**			**87**			**950**
		10-day Rain (RA10-day)	(mm/10-day)	19	19	21	18	18	19	26	26	28	18	18	21	8	8	10	34	34	35	21	21	24	7	7	9	76	76	78	171	171	172	58	58	59	35	35	35	64%
		Ratio of RE10-day (ER10)		17	17	19	16	16	17	23	23	24	16	16	18	8	8	10	28	28	29	19	19	21	7	7	9	48	48	49	59	59	59	42	42	42	29	29	29	
		RE10-day	(mm/10-day)	**17**	**17**	**19**	**16**	**16**	**18**	**23**	**23**	**24**	**16**	**16**	**19**	**8**	**8**	**9**	**28**	**28**	**30**	**19**	**19**	**21**	**7**	**7**	**8**	**48**	**48**	**49**	**59**	**59**	**58**	**42**	**42**	**42**	**29**	**29**	**29**	**950**
18.	**1992**																																							
		Monthly Rain (RAm)	(mm/month)		0			0			0			**0**			124			53			8			95			117			833			209			0			1,439
		Monthly Effec. Rain (ERm)	(mm/month)		**0**			**0**			**0**			**0**			**99**			**49**			**8**			**81**			**95**			**208**			**139**			**0**			**679**
		10-day Rain (RA10-day)	(mm/10-day)	0	0	0	0	0	0	0	0	0	0	0	0	41	41	42	17	17	19	2	2	4	31	31	33	39	39	39	277	277	279	69	69	71	0	0	0	47%
		Ratio of RE10-day (ER10)		0	0	0	0	0	0	0	0	0	0	0	0	33	33	34	16	16	17	2	2	4	26	26	28	32	32	32	69	69	70	46	46	47	0	0	0	
		RE10-day	(mm/10-day)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**33**	**33**	**33**	**16**	**16**	**17**	**2**	**2**	**4**	**26**	**26**	**29**	**32**	**32**	**31**	**69**	**69**	**70**	**46**	**46**	**47**	**0**	**0**	**0**	**679**

Table FA.1 CALCULATION SHEET OF EFFECTIVE RAINFALL (ER10-day) (4/5)

River Bsin: Kone **Station: Phu Cat**

No.	Year	Item	Effective rainfall (ER10-day) (mm/10-day)																																					Total
			Jan.			Feb.			Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			(mm/year)
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
19.	**1993**																																							
		Monthly Rain (RAm) (mm/month)		0			0			0			23			125			0			60			26			277			659			327			322			1,819
		Monthly Effec. Rain (ERm) (mm/month)		**0**			**0**			**0**			**22**			**100**			**0**			**54**			**25**			**153**			**191**			**158**			**157**			**860**
		10-day Rain (RA10-day) (mm/10-day)	0	0	0	0	0	0	0	0	0	7	7	9	41	41	43	0	0	0	20	20	20	8	8	10	92	92	93	219	219	221	109	109	109	107	107	108	47%
		Ratio of RE10-day (ER10)	0	0	0	0	0	0	0	0	0	7	7	9	33	33	34	0	0	0	18	18	18	8	8	10	51	51	51	64	64	64	53	53	53	52	52	52	
		RE10-day (mm/10-day)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**7**	**8**	**33**	**33**	**34**	**0**	**0**	**0**	**18**	**18**	**18**	**8**	**8**	**9**	**51**	**51**	**51**	**64**	**64**	**63**	**53**	**53**	**52**	**52**	**52**	**53**	**860**
20.	**1994**																																							
		Monthly Rain (RAm) (mm/month)		0			34			25			0			50			69			0			91			229			329			103			196			1,126
		Monthly Effec. Rain (ERm) (mm/month)		**0**			**32**			**24**			**0**			**46**			**61**			**0**			**78**			**145**			**158**			**86**			**135**			**765**
		10-day Rain (RA10-day) (mm/10-day)	0	0	0	11	11	12	8	8	9	0	0	0	16	16	18	22	22	25	0	0	0	30	30	31	76	76	77	109	109	111	34	34	35	65	65	66	68%
		Ratio of RE10-day (ER10)	0	0	0	10	10	11	8	8	9	0	0	0	15	15	16	20	20	22	0	0	0	26	26	26	48	48	49	53	53	53	28	28	29	45	45	45	
		RE10-day (mm/10-day)	**0**	**0**	**0**	**10**	**10**	**12**	**8**	**8**	**8**	**0**	**0**	**0**	**15**	**15**	**16**	**20**	**20**	**21**	**0**	**0**	**0**	**26**	**26**	**26**	**48**	**48**	**49**	**53**	**53**	**52**	**28**	**28**	**30**	**45**	**45**	**45**	**765**
21.	**1995**																																							
		Monthly Rain (RAm) (mm/month)		0			34			2			20			148			34			11			88			174			669			299			127			1,606
		Monthly Effec. Rain (ERm) (mm/month)		**0**			**32**			**2**			**19**			**113**			**32**			**11**			**76**			**126**			**192**			**155**			**101**			**859**
		10-day Rain (RA10-day) (mm/10-day)	0	0	0	11	11	12	0	0	2	6	6	8	49	49	50	11	11	12	3	3	5.1	29	29	30	58	58	58	223	223	223	99	99	101	42	42	43	53%
		Ratio of RE10-day (ER10)	0	0	0	10	10	11	0	0	2	6	6	8	37	37	38	10	10	12	3	3	5	25	25	26	42	42	42	64	64	64	52	52	52	34	34	34	
		RE10-day (mm/10-day)	**0**	**0**	**0**	**10**	**10**	**12**	**0**	**0**	**2**	**6**	**6**	**7**	**37**	**37**	**39**	**10**	**10**	**12**	**3**	**3**	**5**	**25**	**25**	**26**	**42**	**42**	**42**	**64**	**64**	**64**	**52**	**52**	**51**	**34**	**34**	**33**	**859**
22.	**1996**																																							
		Monthly Rain (RAm) (mm/month)		0			120			0			135			10			27			38			392			706			1353			421			0			3,202
		Monthly Effec. Rain (ERm) (mm/month)		**0**			**97**			**0**			**106**			**10**			**26**			**36**			**164**			**196**			**260**			**167**			**0**			**1062**
		10-day Rain (RA10-day) (mm/10-day)	0	0	0	40	40	40	0	0	0	45	45	45	3	3	4	9	9	9	12	12	14	130	130	132	235	235	236	450	450	453	140	140	141	0	0	0	33%
		Ratio of RE10-day (ER10)	0	0	0	32	32	32	0	0	0	35	35	35	3	3	4	9	9	9	11	11	13	55	55	55	65	65	65	87	87	87	56	56	56	0	0	0	
		RE10-day (mm/10-day)	**0**	**0**	**0**	**32**	**32**	**33**	**0**	**0**	**0**	**35**	**35**	**36**	**3**	**3**	**4**	**9**	**9**	**8**	**11**	**11**	**14**	**55**	**55**	**54**	**65**	**65**	**66**	**87**	**87**	**86**	**56**	**56**	**55**	**0**	**0**	**0**	**1062**
23.	**1997**																																							
		Monthly Rain (RAm) (mm/month)		0			0			0			28			95			66			112			16			330			311			316			115			1,388
		Monthly Effec. Rain (ERm) (mm/month)		**0**			**0**			**0**			**26**			**81**			**59**			**92**			**16**			**158**			**156**			**157**			**94**			**839**
		10-day Rain (RA10-day) (mm/10-day)	0	0	0	0	0	0	0	0	0	9	9	9.5	31	31	33	22	22	22	37	37	38	5	5	6.1	110	110	110	103	103	105	105	105	106	38	38	39	60%
		Ratio of RE10-day (ER10)	0	0	0	0	0	0	0	0	0	9	9	9	26	26	28	20	20	20	30	30	31	5	5	6	53	53	53	52	52	52	52	52	52	31	31	32	
		RE10-day (mm/10-day)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9**	**9**	**8**	**26**	**26**	**29**	**20**	**20**	**19**	**30**	**30**	**32**	**5**	**5**	**6**	**53**	**53**	**52**	**52**	**52**	**52**	**52**	**52**	**53**	**31**	**31**	**32**	**839**
24.	**1998**																																							
		Monthly Rain (RAm) (mm/month)		45			0			19			27			119			11			60			118			224			519			1049			414			2,604
		Monthly Effec. Rain (ERm) (mm/month)		**42**			**0**			**18**			**26**			**96**			**11**			**55**			**96**			**144**			**177**			**230**			**166**			**1061**
		10-day Rain (RA10-day) (mm/10-day)	14	14	17	0	0	0	6	6	6.5	9	9	9	39	39	41	3	3	4.8	20	20	20	39	39	40	74	74	76	172	172	175	349	349	351	137	137	140	41%
		Ratio of RE10-day (ER10)	13	13	15	0	0	0	6	6	6	9	9	9	32	32	33	3	3	5	18	18	18	32	32	32	48	48	48	59	59	59	77	77	77	55	55	56	
		RE10-day (mm/10-day)	**13**	**13**	**16**	**0**	**0**	**0**	**6**	**6**	**6**	**9**	**9**	**8**	**32**	**32**	**32**	**3**	**3**	**5**	**18**	**18**	**19**	**32**	**32**	**32**	**48**	**48**	**48**	**59**	**59**	**59**	**77**	**77**	**76**	**55**	**55**	**56**	**1061**

Table FA.1 CALCULATION SHEET OF EFFECTIVE RAINFALL (ER10-day) (5/5)

River Bsin: Kone **Station: Phu Cat**

No.	Year	Item		Effective rainfall (ER10-day) (mm/10-day)																																			Total
				Jan.			Feb.			Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	(mm/year)
25.	**1999**																																							
		Monthly Rain (RAm)	(mm/month)		104			38			10			101			103			53			20			11			107			743			750			439			2,479
		Monthly Effec. Rain (ERm)	(mm/month)		**86**			**36**			**10**			**84**			**86**			**48**			**19**			**11**			**89**			**199**			**200**			**169**			**1037**
		10-day Rain (RA10-day)	(mm/10-day)	34	34	36	12	12	14	3	3	4	33	33	35	34	34	35	17	17	19	6	6	8	3	3	5	35	35	37	247	247	249	250	250	250	146	146	147	42%
		Ratio of RE10-day (ER10)		28	28	30	11	11	13	3	3	4	28	28	29	28	28	29	16	16	17	6	6	8	3	3	5	29	29	30	66	66	67	67	67	67	56	56	56	
		RE10-day	(mm/10-day)	**28**	**28**	**30**	**11**	**11**	**14**	**3**	**3**	**4**	**28**	**28**	**28**	**28**	**28**	**30**	**16**	**16**	**16**	**6**	**6**	**7**	**3**	**3**	**5**	**29**	**29**	**31**	**66**	**66**	**67**	**67**	**67**	**66**	**56**	**56**	**57**	**1037**
26.	**2000**																																							
		Monthly Rain (RAm)	(mm/month)		112			0			0			24			307			121			119			179			43			626			330			112			1,972
		Monthly Effec. Rain (ERm)	(mm/month)		**92**			**0**			**0**			**23**			**156**			**97**			**97**			**128**			**40**			**188**			**158**			**92**			**1071**
		10-day Rain (RA10-day)	(mm/10-day)	37	37	38	0	0	0	0	0	0	8	8	8.1	102	102	103	40	40	41	39	39	41	59	59	61	14	14	15	208	208	210	109	109	112	37	37	38	54%
		Ratio of RE10-day (ER10)		30	30	31	0	0	0	0	0	0	8	8	8	52	52	52	32	32	33	32	32	33	42	42	43	13	13	14	62	62	63	53	53	53	30	30	31	
		RE10-day	(mm/10-day)	**30**	**30**	**32**	**0**	**0**	**0**	**0**	**0**	**0**	**8**	**8**	**7**	**52**	**52**	**52**	**32**	**32**	**33**	**32**	**32**	**33**	**42**	**42**	**44**	**13**	**13**	**14**	**62**	**62**	**64**	**53**	**53**	**52**	**30**	**30**	**32**	**1071**