

Appendix 14 Natural Conditions in the Red River Delta

A14.1 General

(1) Outline of the survey

The Study Team carried out the following natural condition surveys in the Red River Segment through Hanoi city (approximately 40 km long, "Survey Area") by sub-letting to the local consulting firm during the 1st period of the site study in Vietnam (Phase 1 stage), to establish the baseline data and information not only mainly for planning and designing of the required facilities related to the project but also for analysis of navigation channel stabilization in the master plan.

- 1) Statistical analysis on meteorological and hydrological data,
- 2) Analysis on historical change of riverbank,
- 3) Measurement of river water flow and suspended solid,
- 4) Measurement of riverbed materials,
- 5) Sectioning Survey (Topographic and bathymetric surveys),
- 6) Geotechnical investigation,
- 7) River structure survey,
- 8) Traffic surveys on channel, port, port access road, and cargo handling, and
- 9) Sand pits survey and stranded boat survey.

At the same time, the Study Team collected existing information and reports relevant to the natural conditions in the Study Area to obtain supplementary data. Based on both of these available reports in the past and the results of the surveys carried out by the Study Team, the natural conditions in the Study Area are summarized hereinafter.

(2) General picture of the Red River Delta

The Red River network, which is the second longest one in Vietnam next to the Mekong River, situated in latitude 20 ° to 25 ° 30' N and longitude 100 ° to 106 ° 07' E. The main Red River originates Nguy Son mountains in China territory flows from north-west to south-east direction across the eighteen (18) cities and provinces of Vietnam and finally reaches at the estuary of Ba Lat in Tonkin Gulf with a total length of 1,126 km

The Red River Delta situates in the tropical monsoon zone, monthly average air temperature varies from 16 ° C in January to 29 ° C in July. An annual average

rainfall is about 1,500 mm in the whole Red River network, rainfall in Chinese territory is rather little 750 mm to 1,036 mm and rainfall in Vietnamese territory increasingly reaches at 1,925 mm. There are specific heavy rainfall areas such as Bac Quang 4,765 mm, Muong Te 2,800 mm and Hoang Lien Son 3,000 mm.

There is very clear two (2) seasonal characteristics of rain in the Red River Delta as follows:

- The rainy season prevails from May to October, maximum rainfall occurs in July and August, an amount of rainfall in this season shares about eighty (80) % of a total annual rainfall.
- The dry season prevails from November to April, minimum rainfall occurs in December and January, the northeast monsoon prevails in this area, an amount of rainfall in this season shares about twenty (20) % of a total annual rainfall.

It is reported that an amount of an annual rainfall in this area does not vary so much every year according to the rainfall data observed in long period.

The flood season prevails from June to October in the Red River in Vietnam, maximum water level occurs in July and August in the past years, in general water level and current change rapidly and suddenly due to characteristics of the wide mountainous catchment area with high slope.

The catchment area of the Red River is 1 69,000 km², about a half of 82,400 km² is located in China territory and about 1,000 km² in Laos territory as seen in **Figure A14.1.1**.

The Red River Segment through Hanoi city can be divided into the following three (3) stretches due to the topographic characteristics:

Table A14.1.1 Stretches of the Red River Segment

Stretches	Dong Lai – Cua Duong	Cua Duong – Thanh Tri	Thanh Tri – Van Phuc
Chainage (Length)	Km 0 to km 17 (17 km)	Km 17 to km 27 (10 km)	Km 27 to km 38 (11 km)
Distance between 2 dykes (m)	1,200m to 4,050m	1,250m to 2,800m	2,100m to 6,500m
Channel width in WL +9 m	700m to 1,700m	720m to 1,600m	450m to 1,050m
Channel width in WL +6 m	500m to 1,200m	300m to 800m	300m to 900m

Source) Pre-Feasibility Study of Red River - Hanoi Section - Rehabilitation Project

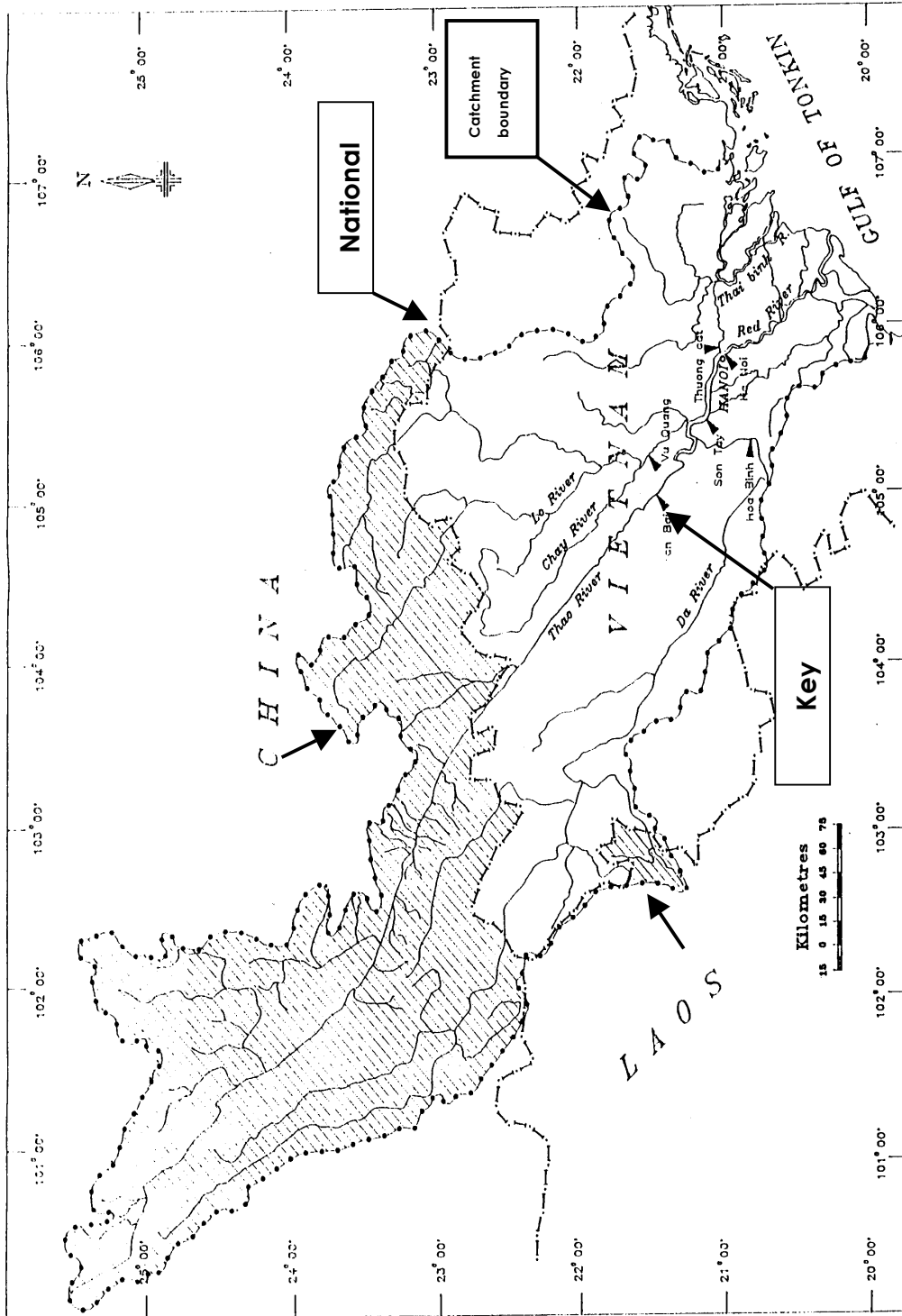


Figure A14.1.1 Catchment Area of the Red River

Source) Red River Master Plan, WB, December 1994

A14.2 Meteorological and hydrological conditions

Based on the collected existing data and the results of the natural condition surveys carried out by the Study Team, the natural conditions in the Survey Area is summarized as mentioned hereinafter.

The existing data were collected from the following three National stations:

1. National Meteorological Station located at Lang, Dong Da district - Hanoi (approx. $105^{\circ} 48'E$, $21^{\circ} 01'N$). The station was established in 1956. The collected data covers the period during 1956-2000.
2. Hanoi National Hydrological Station locates near Long Bien bridge - Gialam side (approx. $105^{\circ} 51'21''E$, $21^{\circ} 01' 53''N$). The station was established in 1902. Water level and discharge data are available from 1956 to 2000. Suspended solids has been measured since 1975.

Since 1/1/1995 water levels have been referred to National Land Survey Datum (mean sea level in Hon Dau), which is 16cm lower than old datum used in the past.

3. Thuong Cat National Hydrological Station locates at about 3.4Km upstream of Duong bridge - Gialam district (approx. $105^{\circ} 52'23''E$, $21^{\circ} 04' 20''N$). The station was established in 1917. Water level and discharge data are available from 1956 to 2000. Suspended solids has been measured since 1975.

Since 1/1/1995 water levels have been referred to National Land Survey Datum.

The maximum, minimum or extreme values of meteorological and hydrological data were summarized to prepare the fundamental information for determination of the design conditions as shown in **Table A14.2.1** below.

Table A14.2.1 Representative Values of Meteorological and Hydrological Data in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

Meteorological Items	Case	Value	Observed Date
Wind	Max.	34 m/sec	8/7/1956
Air temperature	Max.	40.1	18/6/1983
	Min.	7.0	25/1/1983 & 27/12/1982
Rainfall	Annual max.	2536 mm	1994
	Annual min.	1033 mm	1988
	Monthly max.	614 mm	11/1984 & 6/1998
	Daily max.	395 mm	10/11/1984
	Hourly max.	115 mm	5h 15/7/1999
Air pressure	Max.	1,033 mb	21/1/1983
	Min.	981 mb	8/7/1956
Sunny hour	Annual max.	1,870 hours	1987
	Annual min.	1,281 hours	1997
	Monthly max.	260 hours	5/1967
	Monthly min.	2 hours	2/1984
Water level	Highest Water Level (Hanoi station)	13.97 m	22/8/1971

Source) JICA Study Team

(1) Wind

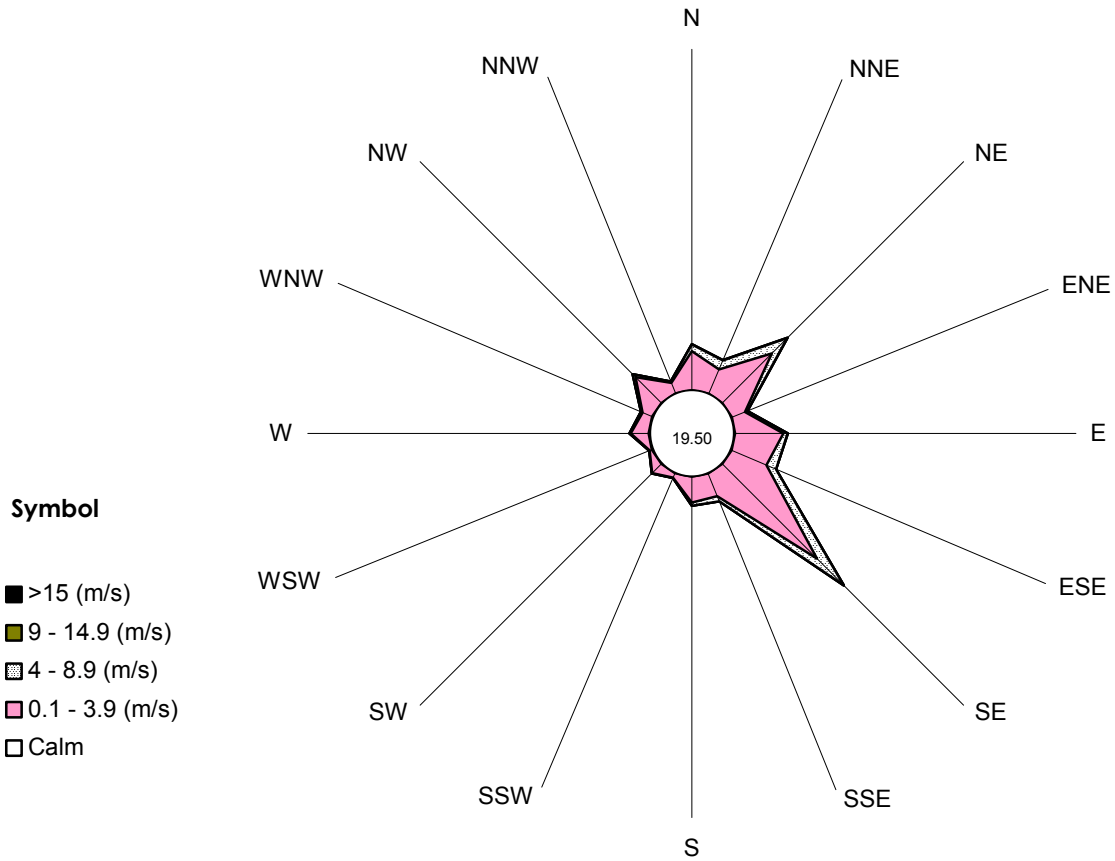
1) Annual wind

Wind data observed at National Meteorological Station (Lang station) at intervals of six (6) hours in the past forty five (45) years during 1956 to 2000 were collected. As seen in Table A1.2.2, the maximum wind speed of 34 m/sec was recorded on 8 July 1957 on occasion of Typhoon.

It is noted that there are two (2) prevailing wind directions, i.e. NE and SE in annual wind rose as seen in **Table A14.2.2**.

According to monthly wind roses it is found that NE wind direction occurs from November to January with frequency of 15.1 to 21.8 %, and SE direction occurs from February to October with frequency of 12.2 to 35.7 % respectively.

Table A14.2.2 Annual Wind Rose in Hanoi



(Based on data measured at Lang station during 1957 - 2000)

Dir.	Speed		0.1 to 3.9 (m/s)		4.0 to 8.9 (m/s)		9.0 to 14.9(m/s)		>15 (m/s)		Total	
	Occur.	%	Occur.	%	Occur.	%	Occur.	%	Occur.	%	Occur.	%
N			3203	4.99	563	0.88	6	0.01	2	0.00	3774	5.88
NNE			2157	3.36	815	1.27	16	0.02			2988	4.65
NE			5721	8.91	1788	2.78	44	0.07	1	0.00	7554	11.76
ENE			1157	1.80	224	0.35	4	0.01	1	0.00	1386	2.16
E			3962	6.17	359	0.56	2	0.00	1	0.00	4324	6.73
ESE			3090	4.81	872	1.36	3	0.00	1	0.00	3966	6.17
SE			10979	17.09	3091	4.81	11	0.02	1	0.00	14082	21.92
SSE			1989	3.10	486	0.76	6	0.01			2481	3.86
S			2136	3.33	270	0.42	2	0.00			2408	3.75
SSW			389	0.61	50	0.08	1	0.00			440	0.68
SW			1062	1.65	55	0.09	1	0.00	1	0.00	1119	1.74
WSW			198	0.31	9	0.01					207	0.32
W			1480	2.30	92	0.14	2	0.00			1574	2.45
WNW			839	1.31	153	0.24	3	0.00			995	1.55
NW			2986	4.65	363	0.57	2	0.00	1	0.00	3352	5.22
NNW			929	1.45	126	0.20	1	0.00			1056	1.64
Calm	12529	19.50									12529	19.50
Total	12529	19.50	42277	65.82	9316	14.50	104	0.16	9	0.01	64235	100

2) Monthly maximum wind speed

Monthly average and maximum wind speeds in Hanoi are shown in **Table A14.2.3** below. From these tables, it can be seen that monthly average wind speed and average of monthly maximum wind speed in the past forty five (45) years are 1.9 m/sec. (1.6 to 2.2 m/sec.) and 11.8 m/sec. (10.0 to 14.1 m/sec.) respectively.

Average monthly wind speed in Hanoi varies from 10.6 m/sec. in November to 13.4 m/sec. in May as seen in **Table A14.2.3** below.

Table A14.2.3 Monthly Maximum Wind Speed in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

(Unit: m/sec.)

Wind Velocity	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	2.0	2.1	2.2	2.1	2.2	1.9	1.9	1.7	1.6	1.7	1.7	1.8	1.9
Average of monthly max.	10.8	10.0	10.8	11.7	13.4	12.7	14.1	13.2	11.8	11.4	10.8	10.9	11.8
Max. of monthly max.	18	14	15	20	30	28	34	31	28	17	22	18	
Direction	NE	NE	NNE	W	SW	WNW	N	E	ENE	NE	NE	NE	

3) Maximum wind speed by Probability of occurrence

As the results of statistical analysis by the Study Team, based on annual maximum wind speeds in the past forty five (45) years (1956 to 2000), the estimated wind speeds by probability of occurrence are obtained as shown in **Table A14.2.4** below. In this connection, maximum wind speed of fifty-year return period (i.e. 2 % of probability) is predicted as 33.0 m/sec.

Table A14.2.4 Maximum Wind Speed by Probability of Occurrence in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

(Unit: m/sec.)

Wind Velocity	Probability of Occurrence (%)											
	0.1	1	2	5	10	20	30	50	75	90	95	99.9
Max. wind	44.5	35.9	33.0	29.4	26.5	23.2	21.1	18.2	15.2	13.3	12.3	10.1

Source) JICA Study Team

4) Typhoons and tropical depressions

Number of the typhoons and tropical depressions (TD) passed in the north Vietnam region of Latitude 19 - 22 ° North (Hanoi city N 21 °) in the past 26 years from 1954 to 1980 was counted as 64 times as seen in **Figure A14.2.2**.

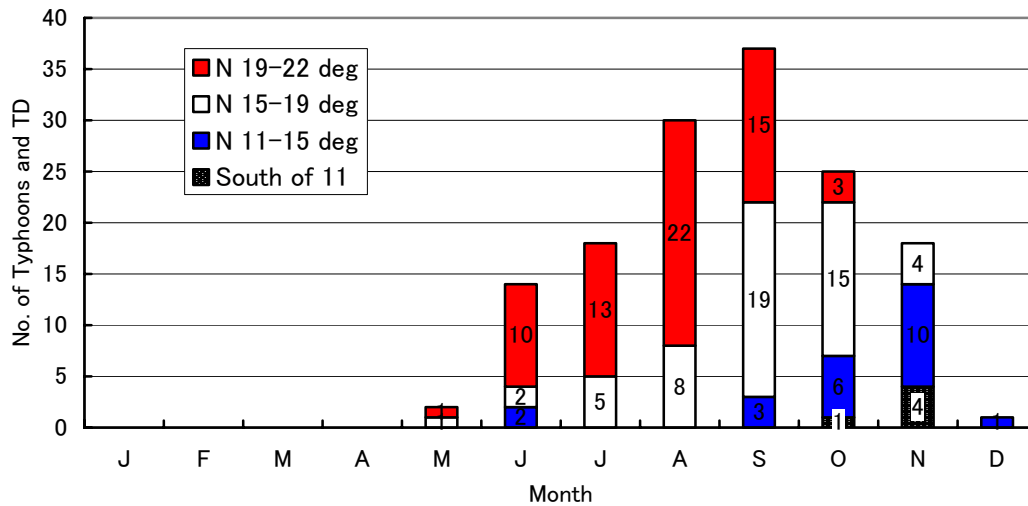


Figure A14.2.2 Number of Typhoons and TD by Region of Vietnam (1954 to 1980)

Source) Report on Storm Characteristics, Marine Hydro-meteorological Center, July 1995

(2) Rainfall

1) Monthly rainfall

The rainfall in the Survey Area is clearly characterized by two monsoon seasons, i.e. the dry and rainy seasons. As seen in **Table A14.2.5** below, monthly average rainfall in Hanoi in the past forty five (45) years during 1956 to 2000 could be summarized as follows:

Rainy season: May to October average monthly rainfall is 182 to 282 mm/month.

Dry season: November to April average monthly rainfall is 21 to 97 mm/month

Table A14.2.5 Monthly Maximum and Minimum Rainfall in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

(Unit: mm)

Rainfall	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	23.6	29.4	50.0	97.1	181.8	251.0	262.4	282.3	227.3	143.2	67.5	20.8
Monthly max.	97.4	90.8	259.5	268.3	550.7	522.7	491.7	664.8	562.0	407.4	614.4	103.7
Monthly min.	0.8	2.7	9.0	12.7	22.4	39.3	61.6	39.4	29.1	3.2	0.0	0.0

2) Rainfall by probability of occurrence frequency

As the results of statistical analysis by the Study Team, based on hourly maximum rainfall in the past forty five (45) years (1956 to 2000), the estimated rainfall by probability of occurrence are obtained as shown in **Table A14.2.6** below. In this connection, hourly maximum rainfall of ten-year return period (i.e. 10 % of probability) is predicted as 88 mm/hour.

Table A14.2.6 Maximum Hourly Rainfall by Probability of Occurrence in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

Unit: mm/hour

Rainfall	Probability of Occurrence (%)											
	0.1	1	2	5	10	20	30	50	75	90	95	99.9
Max. rainfall	143	118	109	98	88	77	70	59	46	37	32	18

Source) JICA Study Team

(3) Air temperature

Monthly average and maximum air temperature in Hanoi are shown in **Table A14.2.7** below. From these tables, it can be seen that monthly average temperature and average of monthly maximum temperature in the past forty five (45) years are 18.1 (16.4 to 28.5) and 27.5 (26.3 to 36.5) respectively.

Table A14.2. 7 Monthly Maximum and Minimum Air Temperature in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

(Unit:)

Air Temperature	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	16.4	17.2	20.0	23.9	27.0	28.9	29.2	28.5	27.4	24.8	21.5	18.1
Average of monthly max.	26.3	27.4	29.3	32.5	36.5	37.0	36.8	35.7	34.2	32.5	30.3	27.5
Average of monthly min.	9.1	9.8	12.6	16.9	20.5	22.9	23.5	23.5	22.0	17.8	14.0	10.2
Maximum of monthly max.	31.5	34.1	36.1	38.8	39.8	40.1	39.1	38.2	36.5	34.4	34.7	31.5
Minimum of monthly min.	5.4	5.0	7.0	12.9	17.3	20.0	21.0	21.8	16.1	13.9	8.5	5.1

(4) Atmospheric pressure

Monthly average, average of monthly maximum, and average of monthly minimum of atmospheric pressure in Hanoi are shown in **Table A14.2.8** below.

From these tables, it can be seen that monthly average atmospheric pressure varies from 985 mb in September to 1019 mb in December, generally maximum atmospheric pressure appears in January and minimum atmospheric pressure appears in July.

Table A14.2. 8 Monthly Maximum and Minimum Atmospheric Pressure in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

(Unit: mb)

Atmospheric Pressure	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	1018	1016	1013	1009	1006	1003	1002	1003	985	1013	1017	1019
Average of monthly max.	1027	1026	1024	1018	1013	1008	1008	1008	1014	1020	1025	1027
Average of monthly min.	1008	1008	1003	1001	998	996	994	996	1000	1006	1009	1010
Maximum of monthly max.	1033	1032	1033	1029	1020	1012	1011	1013	1019	1026	1030	1033
Minimum of monthly min.	1004	998	996	997	994	989	981	989	995	1000	1004	1005

(5) Air humidity

Monthly average, average of monthly minimum, and minimum of monthly minimum of relative air humidity in Hanoi are shown in **Table A14.2.9** below.

From these tables, it can be seen that monthly average relative air humidity varies from 78 % in December to 86 % in April.

Table A14.2.9 Monthly Average and Minimum Relative Air Humidity in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

(Unit: %)

Relative Air Humidity	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	81	81	86	86	83	82	82	84	83	81	79	78
Average of monthly min.	40	45	49	53	48	50	52	57	48	40	38	37
Minimum of monthly min.	21	22	24	32	29	32	36	47	31	24	26	24

(6) Shining hour

Monthly average, monthly maximum, and monthly minimum of shining hour in Hanoi are shown in **Table A14.2.10** below.

From these tables, it can be seen that monthly average shining hour varies from 48.9 hours in February to 192.6 hours in July.

Table A14.2.10 Monthly Maximum and Minimum Shining Hour in Hanoi

(Based on data measured at Lang station during 1956 – 2000)

Unit: hour

Shining Hour	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	73.7	48.9	48.8	89.9	181.9	164.8	192.6	174.8	176.7	165.8	140.3	124.1
Monthly max.	178.3	117.9	109.5	146.0	254.5	259.7	251.7	248.6	243.6	247.0	222.3	204.8
Monthly min.	14.5	1.9	3.6	33.9	104.6	85.1	77.3	114.5	92.9	95.5	70.9	45.9

(7) Fog

Monthly average, monthly maximum, and monthly minimum day of foggy days in Hanoi are shown in **Table A14.2.11**.

From these tables, it can be seen that average of monthly foggy days varies from 1.0 day in July to 4.0 days in December. Generally fog prevails in winter season.

Table A14.2. 11 Monthly Maximum and Minimum Foggy Day in Hanoi
(Based on data measured at Lang station during 1956 – 2000)

(Unit: day)

Foggy Day	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	2.7	2.1	2.5	1.5	1.3	1.0	1.0	1.0	1.1	1.9	2.7	4.0
Monthly max.	10	4	7	3	2	1	1	1	2	10	11	12
Monthly min.	1	1	1	1	1	1	1	1	1	1	1	0

(8) Water levels

1) Water Levels in the Red River Delta

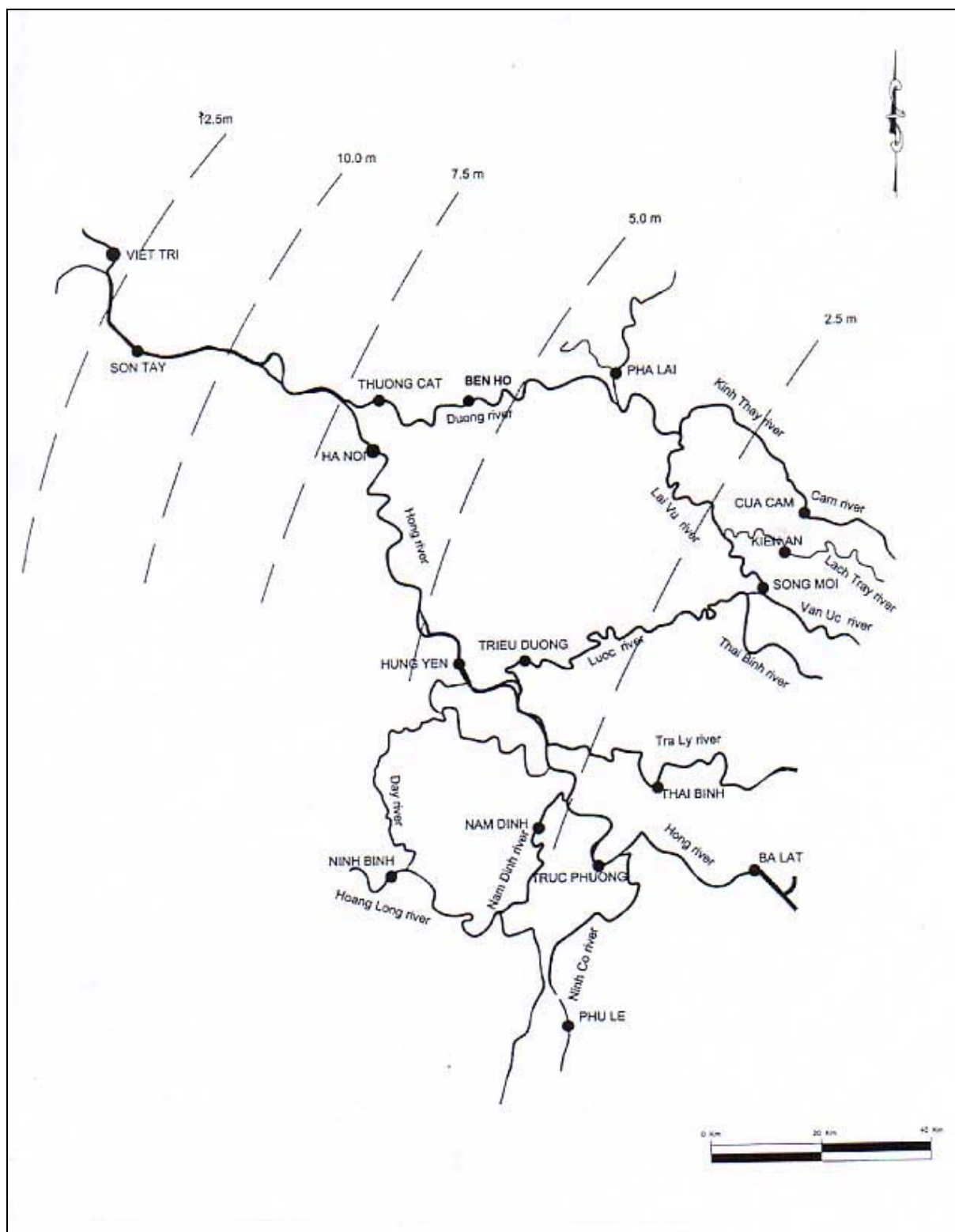
There are 40 Hydro-meteorological Stations in the Red River Delta from Viet Tri to the sea. Among them 17 stations are selected, and water level data are collected, which are summarized in **Table A.14.2.12**.

The distribution of 1) Average Water Level during Flood Season, 2) Mean Water Level, and 3) Average Water Level during Dry Season are illustrated in **Figure A.14.2.3 (1) to (3)**.

Table A14.2.12 Water Levels observed at Hydro-meteorological Stations in the Red River Delta

(Unit: cm)

No.	Name of Stations	Locations		Water Levels				Mean Water Level	Period
		East	North	HHWL	LLWL	LLWL	LLWL		
14	Viet Tri	105d 25'52"	21d 17'42"	1810	22/08/71	547	9/05/60	921	1960-2000
13	Son Tay	105d30'	21d09'	1619	21/08/71	347	7/5/60	775	1959-2000
16	Hung Yen	106d04'	20d37'	841	22/08/71	12	11/04/67	241	1960-2000
38	Nam Dinh	106d10'41"	20d15'41"	537	22/08/71	-64	12/03/59	122	1959-2000
33	Truc Phuong	106d18'28"	20d19'08"	370	22/08/71	-93	27/03/74	66	1965-2000
26	Thai Binh	106d30'20"	20d27'20"	420	22/08/71	-95	27/03/74	82	1961-2000
28	Ba Lat	106d31'00"	20d19'03"	221	16/07/71	-133	29/12/74	20	1961-2000
6	Pha Lai	106d17'35"	21d06'55"	730	22/08/71	-15	01/03/59	179	1959-2000
20	Song Moi (Tien Tien)	106d31'40"	20d45'47"	248	23/08/96	-119	27/03/74	36	1968-2000
17	Trieu Duong	106d07'30"	20d39'00"	771	22/08/71	-25	5/04/69	189	1962-2000
23	Cua Cam	106d50'	20d46'	237	22/07/86	-195	09/04/69	1	1961-2000
22	Kien An	107d37'18"	20d49'06"	212	21/12/72	-187	02/01/68	1	1961-2000
35	Phu Le	106d12'14"	20d03'03"	238	18/07/71	-140	29/12/62	9	1960-2000
39	Ninh Binh	105d58'39"	20d16'45"	382	13/09/85	-67	01/03/59	78	1959-2000
12	Thuong Cat	105d52'23"	21d04'20"	1339	22/08/71	146	26/04/58	500	1957-2000
15	Hanoi	105d51'21"	21d01'53"	1397	22/08/71	155	09/05/60	486	1956-2000
11	Ben Ho	106d04'	21d04'	970	22/08/71	7	9/04/63	300	1961-2000



**Figure A14.2.3 (1) Distribution of Water Levels in the Red River Delta
(Average during Flood Season)**

Source) Study Team

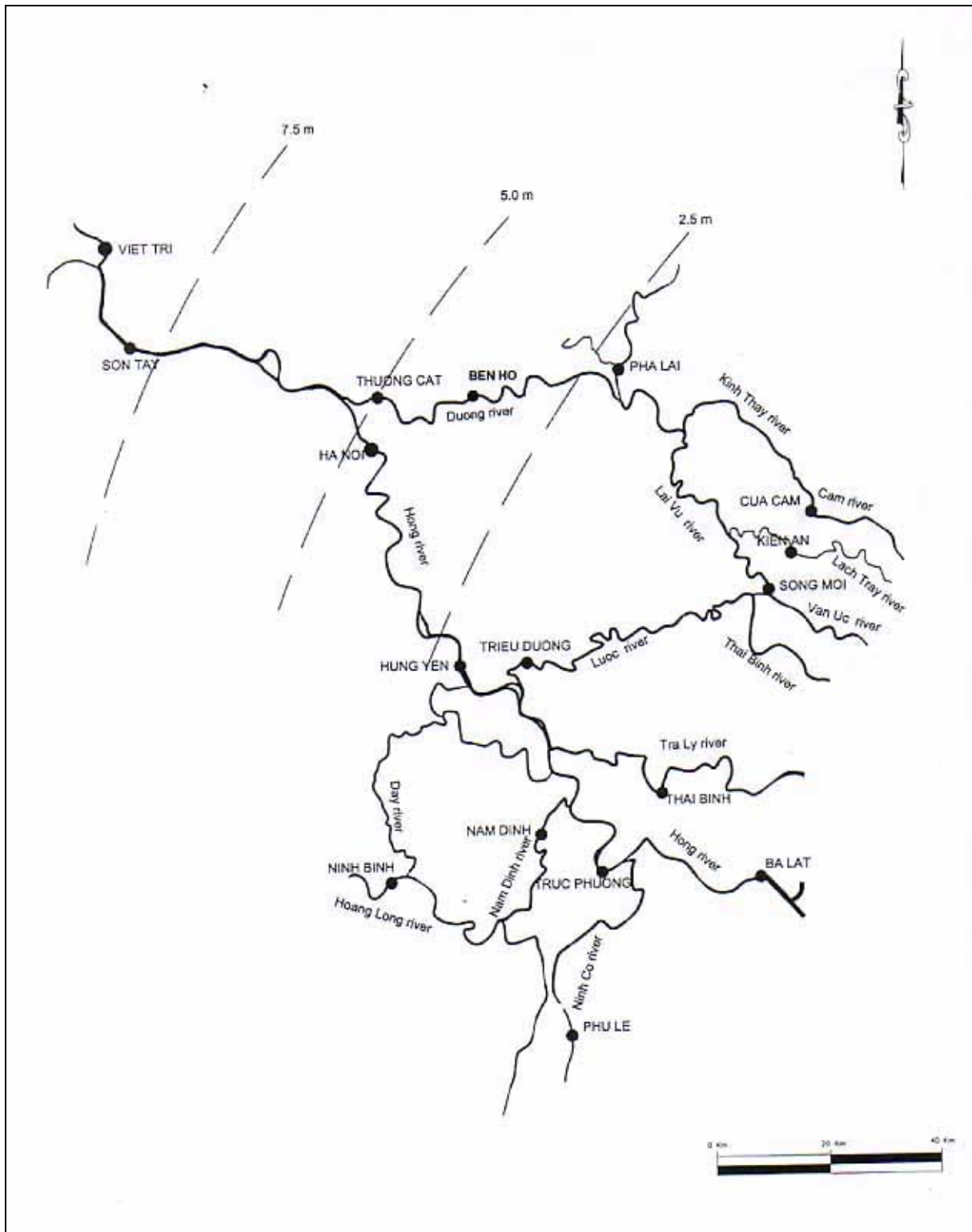


Figure A14.2.3 (2) Distribution of Water Levels in the Red River Delta (Mean for All Seasons)

Source) Study Team

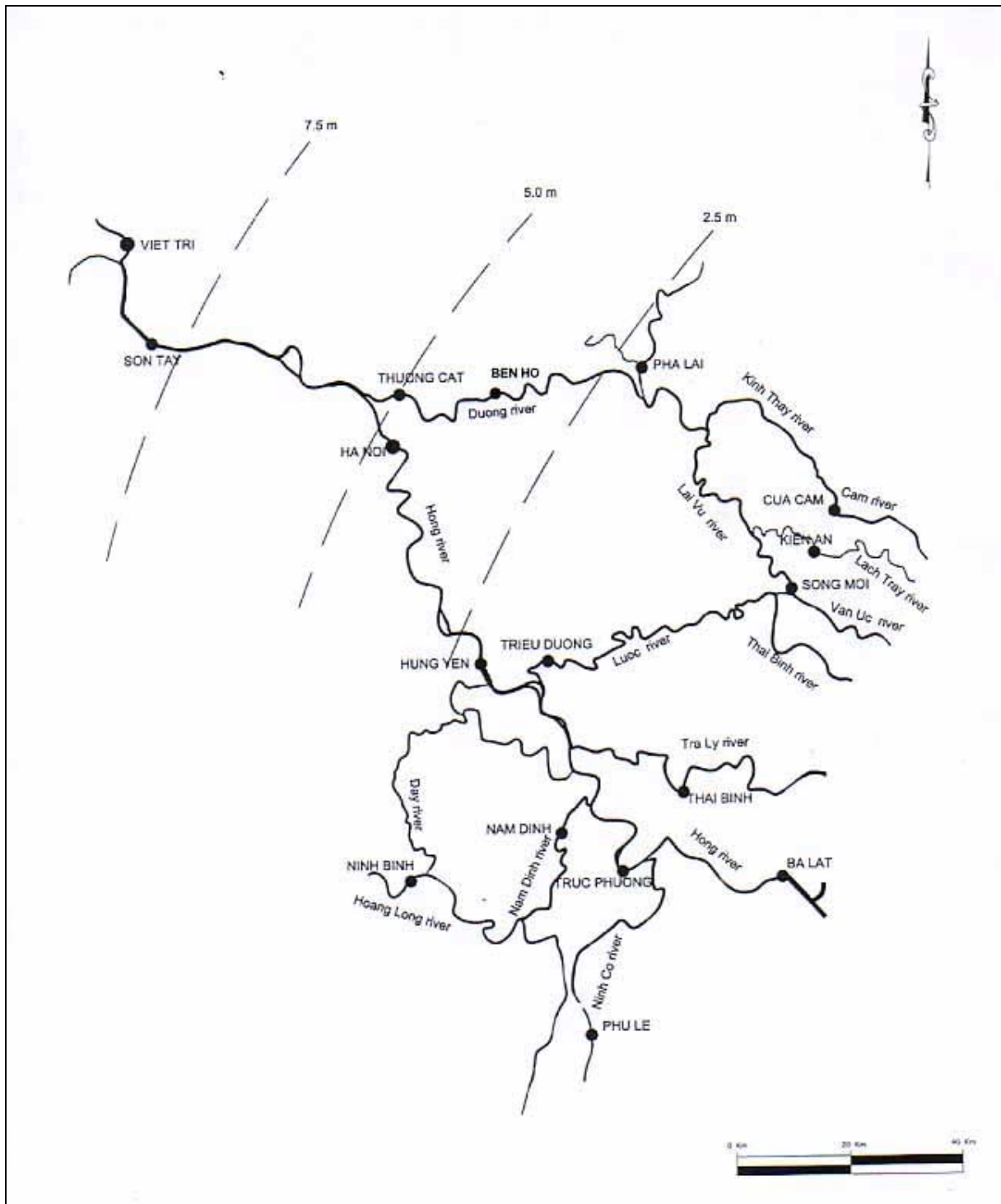


Figure A14.2.3 (3) Distribution of Water Levels in the Red River Delta (Average during Dry Season)

Source) Study Team

2) Water levels at Hanoi

Based on data observed at Hanoi Hydro-meteorological Station, representative water levels were given as seen in **Table A14.2.13** below.

Table A14.2.13 Representative Water Levels in Hanoi

(Measured at Hanoi Gauging Station)

Representative Water Levels	Elevation (NLSD: m)
Highest Water Level (22 August 1971 Hanoi station)	+13.97
Highest Water Level (22 August 1971 Thuong cat station)	+13.39
Mean Water Level in Flood Season (May to October)	+7.34
Annual Mean Water Level	+5.04
Mean Water Level in Dry Season (November to April)	+3.47
Annual Lowest Water Level	+2.70 to +2.90
Lowest Water Level (27 March, 1956)	+1.73

Source) JICA Study Team, and Pre-Feasibility Study of Red River - Hanoi Section - Rehabilitation Project

These water levels are shown in "National Land Survey Datum (NLSD) (zero m = mean water level at the Hon Dau Island in Hai Phong city)", which is 1.86 m higher than water levels referred to "Chart Datum Level (zero m = lowest water level). "National Land Survey Datum is also called as "National Elevation System" in Vietnam.

Average annual highest water level was +10.48 m and lowest one was 2.42m as summarized in **Table A14.2.14** below.

Table A14.2.14 Annual Highest and Lowest Water Levels in Hanoi

(Hanoi Gauging Station 1986 –1998)

(Unit: + m above NLSD)

Year	Highest	Date	Lowest	Date	Year	Highest	Date	Lowest	Date
1986	12.19	29/7	2.01	26/3	1993	9.46	26/8	2.82	16/3
1987	10.02	25/8	2.03	31/3	1994	10.47	19/7	2.68	31/12
1988	9.99	10/9	1.91	5/4	1995	11.57	19/8	2.82	22/3
1989	10.07	14/6	1.96	23/2	1996	12.43	21/8	2.40	3/1
1990	11.78	31/7	2.44	4/5	1997	11.09	24/9	2.86	3/2
1991	11.33	16/8	2.70	28/4	1998	11.00	13/7	2.22	31/12
1992	11.30	27/6	2.62	4/1	Aver.	10.48		2.42	

3) Water levels by probability of occurrence

As the results of statistical analysis by the Study Team, based on annual highest water level in the past forty five (45) years (1956 to 2000), the estimated highest water level by probability of occurrence are obtained as shown in **Table A14.2.15** below. In this connection, for example highest water level of twenty-year return period (i.e. 5 % of probability) is predicted as +11.48 m above NLSD.

Table A14.2.15 Highest Water Level by Probability of Occurrence in Hanoi

(Based on measured data during 1956 – 2000 at Hanoi and Thuong Cat Stations)

(Unit: m above NLSD)

Water Level	Probability of Occurrence (%)											
	0.1	1	2	5	10	20	30	50	75	90	95	99.9
Hanoi station	14.65	13.57	13.22	12.67	12.23	11.48	11.37	10.85	10.23	9.73	9.46	8.57
Thuong Cat station	14.30	13.10	12.68	12.16	11.70	11.18	10.87	10.34	9.77	9.34	9.11	8.44

Source) JICA Study Team

A14.2-2 Decision No. 59/2002/QĐ-BNNPTNT dated July 3, 2002

Water Level for Dyke Design along the Red River and Thai Binh River Systems

Minister of Agriculture and Rural Development

Pursuant to the water resources law dated May 20, 2000

Pursuant to the dyke's law dated August 24, 2000

Pursuant to the flood and storm control law date March 8, 1993 and its amendment dated August 24, 2000.

Pursuant to the law on exploiting and protecting irrigation construction dated April 4, 2001

In accordance to the Decree No.73/CP dated November 11, 1995, which provide the right and task as well as structure of MARD

In accordance to the Decree No.62/1999/ND-CP which issue regulation on flood control on the Red River system to protect Hanoi Capital

In accordance to the document No.959/CP-NN dated October 24, 2001, which assign MARD making and approving standard of flood control in the Red River Delta to built Son La Hydro-Electricity plant.

On the Proposal of Manager of Flood Control and Dykes Management Department.

Decision

Article 1: Hanoi dyke (special class) should prevent the flood at water level of 13.4 m. Dykes that class No. I, II, III, should prevent the flood at the level of 13.1 m.

Article 2: Manager of Department of Flood Control and Dykes Management base on this decision to define water level for dyke design at main point of each dyke along the Red River and Thai Binh River.

Article 3: Chief of MARD Administration Department, Manager of Flood Control and Dykes Management Department, Manager of Water and Irrigation Department and related manager take responsibility to carry out this decision.

Minister of MARD

Le Huy Ngo

A14.2-3 Decision No.60/2002/QD-BNNPTNT dated July 05, 2002, Branch Criteria

Minister of MARD

Pursuant to the Water Resources Law dated 20 May 1998;

Pursuant to the Dyke Law dated 24 August 2000;

Pursuant to the Law on Prevent Flood, Storm date 08 March 1993 and the amendment law dated 24 August 2000;

Pursuant to the Law on exploiting and protecting irrigation constructions dated 04 April 2001;

Pursuant to the Decree No. 73/CP dated 01 November 1995 about function, responsibility and right of MARD;

Pursuant to the document No. 959/CP-NN which assign MARD studying and approving Standard of Preventing Flood and Storm at the Red River Delta to build Son La Hydraulic Power Station;

Pursuant to the procedure to studying, approving branch criteria in decision No. 135/1999 - QD-BNN-KHCN dated 01 October 1999;

On the Proposal of Manager of Department of Science and Product Quality, Manager of Department of Dyke Management and Flood Control, Manager of Department of Water Management and Irrigation Construction, Manager of Irrigation Planning Institute;

Decision

Article 1: Issue with this decision branch criteria No. 14TCN 122-2002 to prevent flood in the Red River Delta.

Article 2: This decision will be effected from the date of signing

Article 3: Chief of MARD, Manager of Department of Flood Control and Dykes Management Department, Manager of Water and irrigation Department and manager of related agencies take responsibility to carry out this decision.

Minister of MARD

Le Huy Ngo

A14.2-3 Branch Criteria No.14TCN 122-2002

Standard to Prevent Flood in the Red River Delta

1. General definition

- 1.1. This criteria defines frequency of flood prevention in the Red River Delta and water level for dyke design along the Red River and Thai Binh River systems.
- 1.2. It is used to build and approve Master Plan of flood control's construction in the Red River Delta including reservoir, dyke, flood discharging construction and flood reducing construction

2. Criteria to prevent flood in the Red River Delta

2.1 Frequency to prevent flood in the Red River Delta is following Table 2.1

Table 2.1 Frequency to prevent flood in the Red River Delta

Flood preventing criteria	Inner Hanoi	Other area
1. At present time, to prevent flood in August, 1971		
Frequency to prevent flood, %	0.8	0.8
Period, year	125	125
2. After building Dai Thi Reservoir		
Frequency to prevent flood, %	0.4	0.67
Period, year	250	150
3. After building Son La and Dai Thi Reservoirs		
a. If capacity of Da River Reservoir is 7 Bill. m ³		
Frequency to prevent flood, %	0.2	0.33
Period, year	500	300
b. If capacity of Da River Reservoir is more than 7 Bill. m ³		
Frequency to prevent flood, %	<0.2	<0.33
Period, year	>500	>300

Note) Frequency in table 2.1 already consider impact of other construction such as dyke, reservoir following the flood control plan.

2.2. Water level for dyke design at the Red River and Thai Binh River Systems is to be referred to the following Table 2.2.

**Table 2.2 Water level for dyke design
in the Red River and Thai Binh River Systems**

Preventing flood standard	Hanoi Dyke (Special class)	Dyke class No. I, II, III
Water level at Hanoi, m	13.4	13.1
Water lever at Phalai, m		7.2

Note)

1. Water level for each dyke class at Hanoi (Hanoi Gauging Station) and Pha Lai (Pha Lai Gauging Station) will be used to design for each class
2. Basing to choose the level at Pha Lai (7.2 m) is correlative with 13.1 m at Hanoi
3. Elevation system is national elevation system (14TCN102-2002)

2.3. Building Master Plan and designing new reservoir which have capacity more than 300 million m³ in the Red River and Thai Binh River systems should have enough capacity to prevent flood and should be decided by authority agency and must have opinion of MARD.

Minister of MARD

Le Huy Ngo

A14.2-5 Decision No. 609/QD-PCLB

MARD, Socialist Republic of Vietnam

Hanoi, August 06, 2002

Decision of Minister of MARD

Define Water Level for Dyke Design at Hanoi City

- Pursuant to the Water Resource Law dated May 20, 1998;
- Pursuant to the Law on Dyke date August 24, 2000;
- Pursuant to the Law on Prevention Flood and Storm dated March 08, 1993; the amendment dated August 24, 2000;
- Pursuant to the Decree No. 62/1999/ND-CP dated July 31, 1997 about reducing flood, flood distribution belong to the Red River system to protect Hanoi Capital;
- Pursuant to the Decision No. 355/TTg dated May 28, 1996 of Prime Minister about function, responsibility and right of MARD;
- Pursuant to the Decision No. 59/2002/QD-BNN date July 3, 2002 of Minister of MARD about water level for dyke design along the Red and Thai Binh River Systems;
- On the proposal of Manager of Department of Dyke Management and Flood Control;

Decision

Article 1: Define water level following national elevation system VN72 for dyke design from class III to special class at Hanoi to build, maintain, manage and prevent flood as follows:

No.	Location	River	Km	Dyke class I to III (m)	Special class dyke
1	Son Tay Station	Red	K31+600 (Right bank)	16.30	
2	Long Bien Station	Red	K66+400 (Left bank)	13.10	13.40
3	An Canh Station	Hong	K96+500 (Right bank)	10.60	
4	Thuong Cat Station	Duong	K1+995 (Right bank)	12.90	
5	Ben Ho Station	Duong	K32+500 (Left bank)	10.00	
6	Manh Tan Station	Ca Lo	K6+700 (Right bank)	9.50	
7	Ba Xa Station (Phuc Loc Phuong)	Cau	K28+800 (Right bank)	9.20	
8	Dap Cau Station	Cau	K59+350 (Right bank)	8.20	

Article II: Hanoi People Committee bases on definition in article 1 to manage related agencies to protect dyke safety.

Article III: Chief of MARD Administration Department, Manager of Department of Dyke Management and Flood Control and other agency take responsibility to carry out this decision.

By order of Minister of MARD

Manager of Dyke Management and Flood Control Dept.

Dang Quang Tinh

A14.2-6 Law on Dyke

President

SOCIALIST REPUBLIC OF VIETNAM

Independence - Freedom – Happiness

No.09/L-CTN

Hanoi, September 07, 2000

President's Order

(To promulgate the law - Extract)

President of the Socialist Republic of Vietnam

- In accordance to articles 103 and 106 of the Constitution of the Socialist Republic of Vietnam, 1992;
- In accordance to article 78 of Law on Organization of National Assembly;
- In accordance to article 51 of Law on Promulgated Law;

Promulgate

Law on Dyke;

...

Which was adopted by the Standing Committee of the National Assembly of the Socialist Republic of Vietnam on 24 August 2000.

President of the Socialist Republic of Vietnam

Tran Duc Luong

Source) National Political Publishing House, Hanoi – 2000

Law on Dyke

Dyke is important construction which has been built, maintained by many generations of people to prevent flood, sea water and protect people, production and national, community as well as personal estates;

In order to increase efficiency of state management, increase responsibility of all levels authorities, economic organization, political organization, social - political organization, social - career organization, army units and individual to build, maintain and use dyke;

Pursuant to Constitution of the Socialist Republic of Vietnam, 1992;

Pursuant to Law on Water Resource;

Pursuant to decision of building laws of National Assembly, Legislature X at its 6th Sessions in 2000;

This law makes provisions on dyke.

Chapter I General Provisions

Article 1

1. This law makes provisions on building, maintaining, protecting, using and rescuing dyke.
2. In this law, dyke shall include:
 - a) Dyke to prevent flood water, sea water;
 - b) Embankment to protect dyke;
 - c) Culvert in dyke;
 - d) Other supporting construction.

Article 2

1. Dykes building by variety capital resources are subject to uniform management by the State.
2. The State gives priority to build, maintain dyke. The State encourages

organizations and individuals in Vietnam, foreign organizations and individuals, overseas Vietnamese to invest capital and apply science and technology for the purposes of building, maintaining, protecting, using and rescuing dyke.

Article 3

Dyke is categorized, depending on the importance level of social - economy, defense and public security of each area that is protected by dyke to prevent flood as follows:

- Special class
- I, II, III, IV classes.

Government shall determine dyke class' standard and approve class of each dyke route

Article 4

State organization, economic organization, political organization, social - political organization, social organization, social - career organization, army unit and individual have responsibility to implement all regulations in this law and other regulation in relevant law.

The Fatherland Front Committee and its members shall, within the scope of their duty and powers, take responsibility to propagate people to implement the Law on Dyke.

Article 5

All actions that damage dyke are prohibited.

Chapter II Building and maintaining dyke

Article 6

Building new dyke or maintaining dyke shall follow dyke planning which approved by an authority and shall be conformed with the regulation on procedure, criteria to build and protect dyke.

Article 7

1. Regular building, maintaining dyke is given priority to use public labor following regulation.
2. In the event that land is recovered for building, maintaining, upgrading dyke, land users shall be compensated in accordance with provisions of the laws.

Article 8

The State gives priority to invest in building, maintaining dyke.

Government shall determine expenditure to build, maintain each dyke class.

Chapter III Protect and Use Dyke

Article 9

Sphere of dyke protection includes dyke and surrounding area that impact directly to safety of dyke.

It shall comply with dyke class, technical character of dyke structure and requirement of dyke protection to determine surrounding area.

Government shall determine surrounding dyke area.

Article 10

Organizations, individuals have duty to protect dyke.

If there are any activities (man made or natural disaster) which damage/threaten dyke safety, it should be prevented and reported immediately to authority.

Article 11

Following activities are strictly prohibited:

1. Exploiting land, stone, sand, gravel, mineral resource; digging pond, well and dredging channel within dyke protection's area.
2. Operating construction at dyke protection's area that is not followed regulated procedure/technical criteria.
3. Building construction, house at dyke protection's area, sand bar, riverbed excepting specific construction which is building to prevent flood, storm and for purposes of transport, defense, security and other specific construction.
4. Dumping rubbish at dyke protection's area, sand bar, riverbed; load material on dyke except reserved material for flood, storm prevention.
5. Exploding which damage/threaten to dyke safety except exploding to control flood, which is decided by an authority level.
6. Mechanic vehicle go on dyke, culvert which capacity is over allowance; four wheel vehicle go on dyke if there are break-down, prohibited signal when flood is over alarm level 3, except rescuing/checking dyke vehicle, ambulance, fire-engine.
7. Hoeing grass and loading straw, firewood on the dyke.
8. Other activity which impact directly to dyke safety and flood discharge except activity which got permission of authority following article 12 of this law.

Article 12

In special case, organization, person who wants to carry out following activities must have permission of state authority:

1. To cut/split dyke to build construction within protected dyke area;

2. Exploration boring within protected dyke area;
3. To build specific construction with purposes of preventing flood and storm, transport, defense, security and other within dyke protection area;
4. Use dyke, embankment, culvert to berth ship, vessel, load material;
5. Other activity which shake dyke.

Article 13

1. Ministry of Agriculture and Rural Development (MARD) gives permission for activities in items 1,2,3 and 5 of article 12 of this law if dyke is in class III to special class.
2. The People's Committees of Provinces and Cities under central authority give permission for activities in article 12 if dyke is class IV and item 4 of this law if dyke is from class III to special class.

Article 14

Issuing permission to build, upgrade, improve constructions; dredge channel or exploit sand, grave that are not in sphere of dyke protection but it impacts to dyke safety and flood discharge must have a text agreement of MARD if dyke is class III to special class and agreement of People Committees of Province and City under central authority if dyke is class IV.

Article 15

Dyke safety must be ensured when dyke is improved to use as a road.

Organization, person who improve dyke to use as a road must have permission of MARD if dyke is class III to special class and permission of People Committees of Province/City under central authority if dyke is class IV.

Organizations, persons using dyke as a road has duty to maintain, repair dyke surface following dyke technique and transport criteria.

Article 16

1. Grass should be grown on dyke roof/ body or applied suitable method to prevent erosion.
2. Land within surrounding dyke area is only use to grow rice, short-days crop and stopping wave's tree. Exploiting trees that grow to stop wave shall abide guidance of dyke management authority.

Article 17

Protecting and using historical, cultural relics and places of interest within dyke protected area shall comply with its law and this law as well as relevant laws on dyke protection.

Article 18

1. House, construction which have been existing at protected area, sand bar and riverbed before this law had effective, except specific construction use for defense, preventing flood, transport and security purposes and other specific construction will be resolved as follows:
 - a) House and construction locate at dyke surface, dyke roof, dyke body and within 5 m from dyke foot must be removed. (Applying with all dyke classes).
 - b) House and construction locate far from dyke foot 5 m and within sphere of dyke protection will be continued using but it can not enlarge; owner, user must have a method to ensure dyke safety; in case that construction was built after promulgated date of Dyke Law in 1989 and did not have authority permission, it will be disposed following regulation and depending on violation level.
 - c) House, construction locate at alluvial bank, river bed will be continued using if they do not impact directly to flood discharge; in case of impacting directly to flood discharge, they should be removed; Removing house, construction should be carried out following plan of an authority.
2. Owner, house users whose construction is removed will get compensation or assistance cost following regulation.

Government shall determine this cost.

Article 19

MARD shall cooperate with related agencies to define dyke signal system uniformly.

Article 20

1. Specialized in and responsible labor for dyke management is office that belongs to the People Committees of Province and City under center authority.

Government will define organization structure, duty, power and uniform of these staffs
2. Local authority is encouraged to organize people that do not belong to state office, to manage dyke in order to increasing dyke management at local area.

People Committee of Province and City under Center Authority will define organization structure, duty, power and salary of this force.

Chapter IV Dyke Maintenance

Article 21

1. Dyke maintenance should be implemented regularly in flood season. If flood/storm endangers dyke safety, rescuing dyke should be carried out immediately.
2. Rescuing constructions, which have a connection with dyke safety, is rescuing dyke.

Article 22

1. Government decides and gives guidance for Ministries; corresponding administrative divisions under Government and People's Committees of Province/City under Central Authority to implement works of maintenance/rescuing dyke to ensure dyke safety.
2. MARD takes responsibility to assist Government to administer works of maintenance/ rescuing dyke.
3. Ministries, organization under Government have responsibility to make plan and implement rescuing alternative of construction which connect with dyke safety and take part in rescuing dyke at local area following mobilization decision of Government.
4. People Committee at all levels have responsibility to organize and implement work of maintenance/rescuing dyke to protect dyke following design standard. Chairman of Provincial/City People Committee has responsibility to manage and approve works of maintaining/rescuing dyke; to inspect and encourage every level, every branch to carry out the work.

Article 23.

1. Administrations of dyke maintenance, rescuing dyke of Center Prevention of Flood - Storm Steering Committee, Prevention of Flood-Storm Steering Committee of Ministries, Organization of Government, all authority levels will follow Law on Preventing Flood and Storm.
2. Army Force is in charge of preventing, rescuing dyke and is main force of this work.

Article 24

1. In urgent situation, if dyke is serious threatened, Government will decide flood distribution method which have a connection with two provinces, city following approved alternative; Chairman of Provincial/City People Committee will decides the method if it has connection with dyke safety at local area following approved alternative of Government.

2. Government defines detail urgent situation to distribute flood; resettlement alternative to protect production and life of people, subsidiary for people at flooding area.

Article 25

1. If dyke, construction which has a connection with dyke safety is in danger, Chairman of People Committee at all levels must mobilize labor, material to protect, rescue dyke; remove people out of dangerous area safely.
2. Organization, people whose is mobilized must implement decision of authority. Material, means which are mobilized will be refunded, in case of damage, it will be compensated following regulation. A person who is injure or die when protecting dyke will get subsidiary following articles 28, 29, 30 and 31 of Law on Public Labor.

Chapter V State Management of Dyke

Article 26

State administration of dyke shall include:

1. Building and carrying out basic investigation, plan, policy of building, maintaining, managing, protecting and using dyke as well as rescuing dyke;
2. Promulgating laws, procedure, criteria of building, maintaining, protecting and using dyke as well as rescuing dyke; give guidance to implement these laws;
3. Determining alternative to deal with the case that dyke is broken or in danger;
4. Issuing and drawing permission for activity that is carrying out within sphere of dyke safety;
5. Collecting and managing investigation, information, data about dyke system and constructions, which have a connection with dyke safety;
6. Investing in and organizing the study of applying high technology in building, maintaining , protection, using and rescuing dyke; training technique, professional knowledge for labor;
7. Propagating law, knowledge, experience of management, protection of dyke for people;
8. Inspecting to ensure compliance with the law on dyke; resolution of dyke disputes.
9. Administration of international cooperation in dyke field.

Article 27

1. Government shall uniformly manage dyke.
2. MARD takes responsibility, on behalf of Government, to implement Stage administration of dyke.
3. Ministries, organizations cooperate with MARD to implement dyke administration following government assignment.
4. People Committees at all levels take responsibility in state administration of dyke at local area following government assignment.

Government defines detail duty and power of each dyke administration authority.

Article 28

People Councils, People Committees of City, Province takes responsibility to protect dyke safety in local area following design standard.

Article 29

Chairman of District People Committees under Province, Chairman of Commune People Committees have responsibility to implement work of maintenance, protection, administration of dyke as well as rescuing dyke, solve dyke violation following their duty and power.

Article 30

Dyke inspector is professional and belongs to professional inspector of water resource. Their rights include:

1. Inspection of implementation of dyke law;
2. Resolution of dyke disputes.

Government defines detail organization structure and activity of dyke inspector.

Chapter VI Reward and Penalty

Article 31

Any organization and individual recording notable achievement in building, maintaining, protecting, rescuing dyke shall be rewarded in accordance with the provisions of the laws.

Article 32

1. Any person acting in breach of the provisions of this law shall, according to the degree of infringement, be liable to the following penalties: warning, fine,

suspension, obligation of compensation or prosecution for penal responsibility in accordance with the provisions of the laws.

2. Any person who abuses his office and authority, who behaves irresponsibly, or who shields with his authority who breaches the Dyke Law shall, according to the degree of infringement, be punished in any of the following ways: warning; fine; forced dismissal or prosecution in accordance with the provision of the laws.

Chapter VII Implementation Provisions

Article 33

This law shall come into force on 1 January 2001.

Previous Dyke Law dated 9 November 1989 is replaced by this Law.

All previous provisions contrary to this Law are hereby repealed.

Article 34

Government shall issue detailed provisions for the implementation of this law.

Hanoi, 24 August 2000

On behalf of the Standing Committee of National Assembly

Chairman of the National Assembly

Nong Duc Manh