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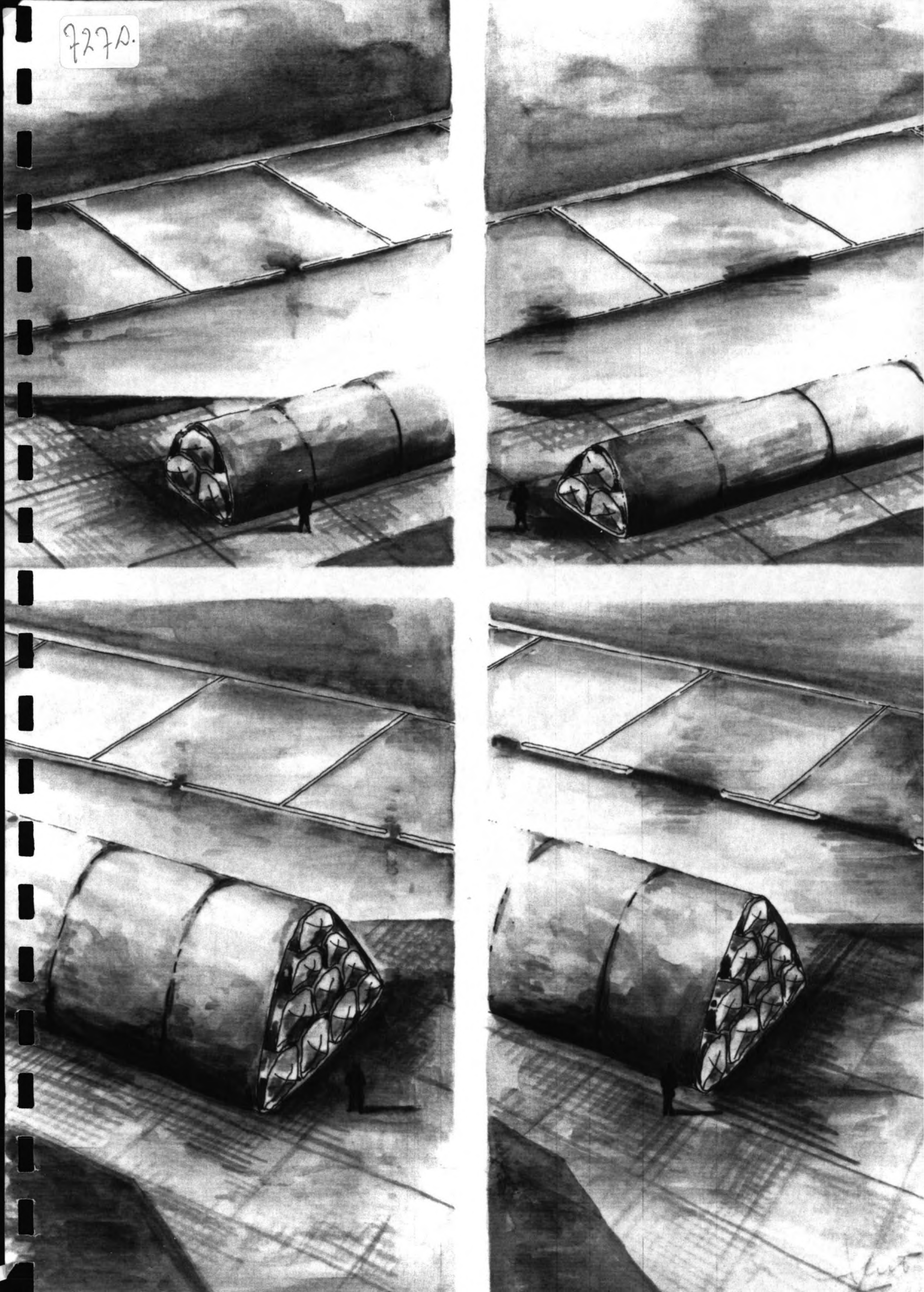


ROTTERDAM PUBLIC WORKS
Harbour Engineering Division

FEASIBILITY STUDY
LANDRECLAMATION SHANGHAI

LAY-OUT part II

The effect of wind waves

Yvette van den Berg
January 1988

6598E/s.876/BH

0. SUMMARY

0.1 Introduction

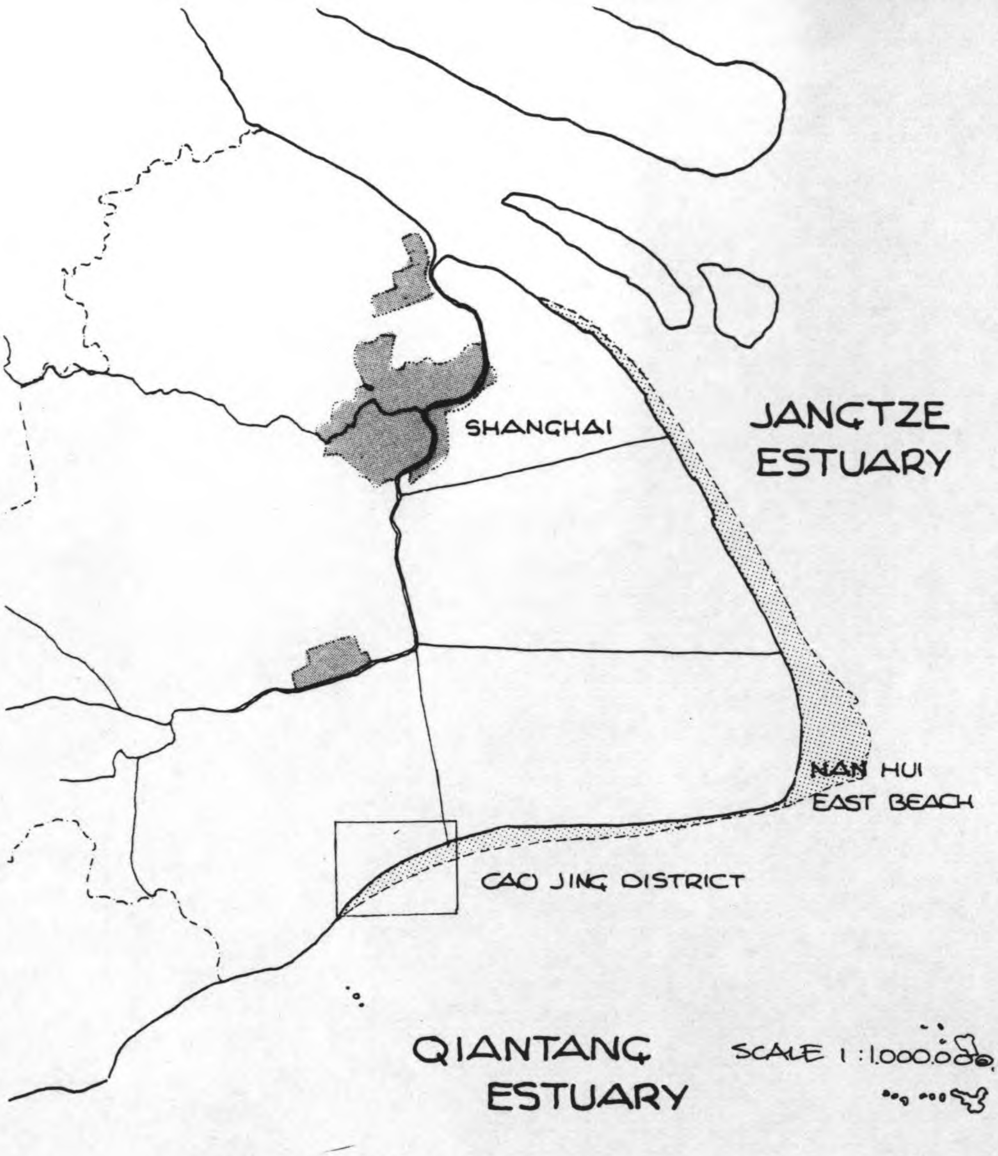
At the Cao Jing district in Shanghai, China, a landreclamation project is planned. The object of this project is to stimulate the natural process of sedimentation. This report comprises the results of a study concerning the optimum lay-out of dikes in the reclamation-area (see <u>Fig. 0.1 and 0.2</u>). In this report particularly the influence of the waves (wind-waves and swell) is discussed. In the foregoing report "LAY-OUT part I" the influence of the tidal motion has been discussed.

In this analysis the wave-climate at the Cao Jing district has been calculated on the basis of measurements at cape Nan Hui, concerning the waves and wind-speeds.
Next, the optimum dimension of the opening-size is determined, based on wave-diffraction.
The optimum dimensions of the field (length and distance) are determined by the admissable fetch-length (for wind-generated waves).
Finally the height of the longitudinal dike is optimized, based on wave-transmission.

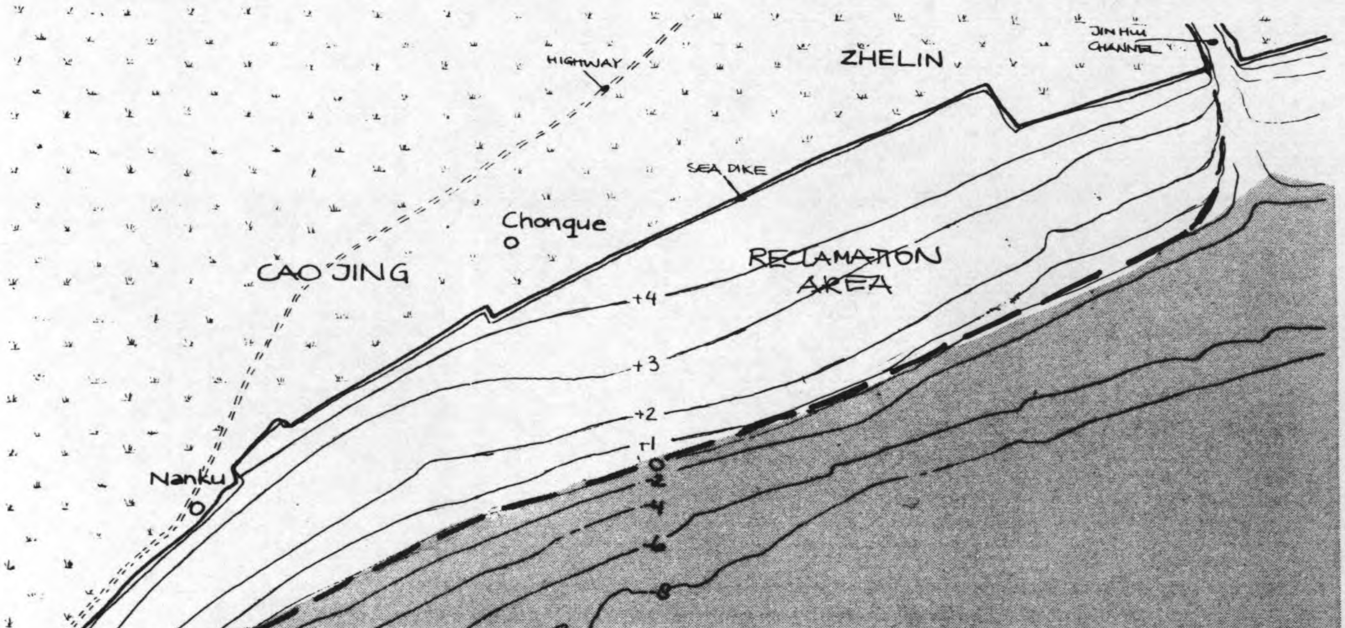
0.2 The water-level at the Cao Jing district

The water-level along the coastal zone of Cao Jing is determined by a tidal motion, by the discharge of the Yangtze river and by the prevailing wind-direction. A "flood season" and a "non-flood season" can be distinguished, in which the "flood" indicates a large discharge of the Yangtze river. Table 0.1 shows the circumstances during flood season and non-flood season.

The tidal motion at Cao Jing consists of a semi-diurnal movement with an average period of 44,700 s (700 tides per year).
The M_2-component forms the farmost important part of the tidal motion.


SHANGHAI
JANGTZE ESTUARY
NAN HUI EAST BEACH
CAO JING DISTRICT
QIANTANG ESTUARY
SCALE 1:1.000.000

0.1


HIGHWAY
ZHELIN
JIN HUI CHANNEL
SEA DIKE
Chonque
CAO JING
RECLAMATION AREA
+4
+3
+2
+1
0
-2
-4
-6
-8
Nanku
SCALE 1: 100.000

0.2

	Non-flood seson	Flood season
- average discharge Yangtze (m3/s)	12,000	40,000
- months (number)	October-April (7)	May-September (5)
- prevailing wind-direction	N-NE	S-SE
- mean sea-level (m)	+1.90	+2.20
- tidal difference (m)	3.90	4.20
LW (average) (m)	-0.20	+0.10
HW (average) (m)	+3.70	+4.30

Table 0.1: average circumstances during the year at the Cao Jing district

Extreme high water-levels occur mainly during the flood season, extreme low water-levels during the non-flood season.
For the design of the construction of the dike, the extreme high water-level is interesting; the distribution is given in Fig. 0.3.

In extreme conditions, the significant wave-height at shallow water is directly dependent on the waterdepth:

$H_s = 0.5\ d$ ....(8)

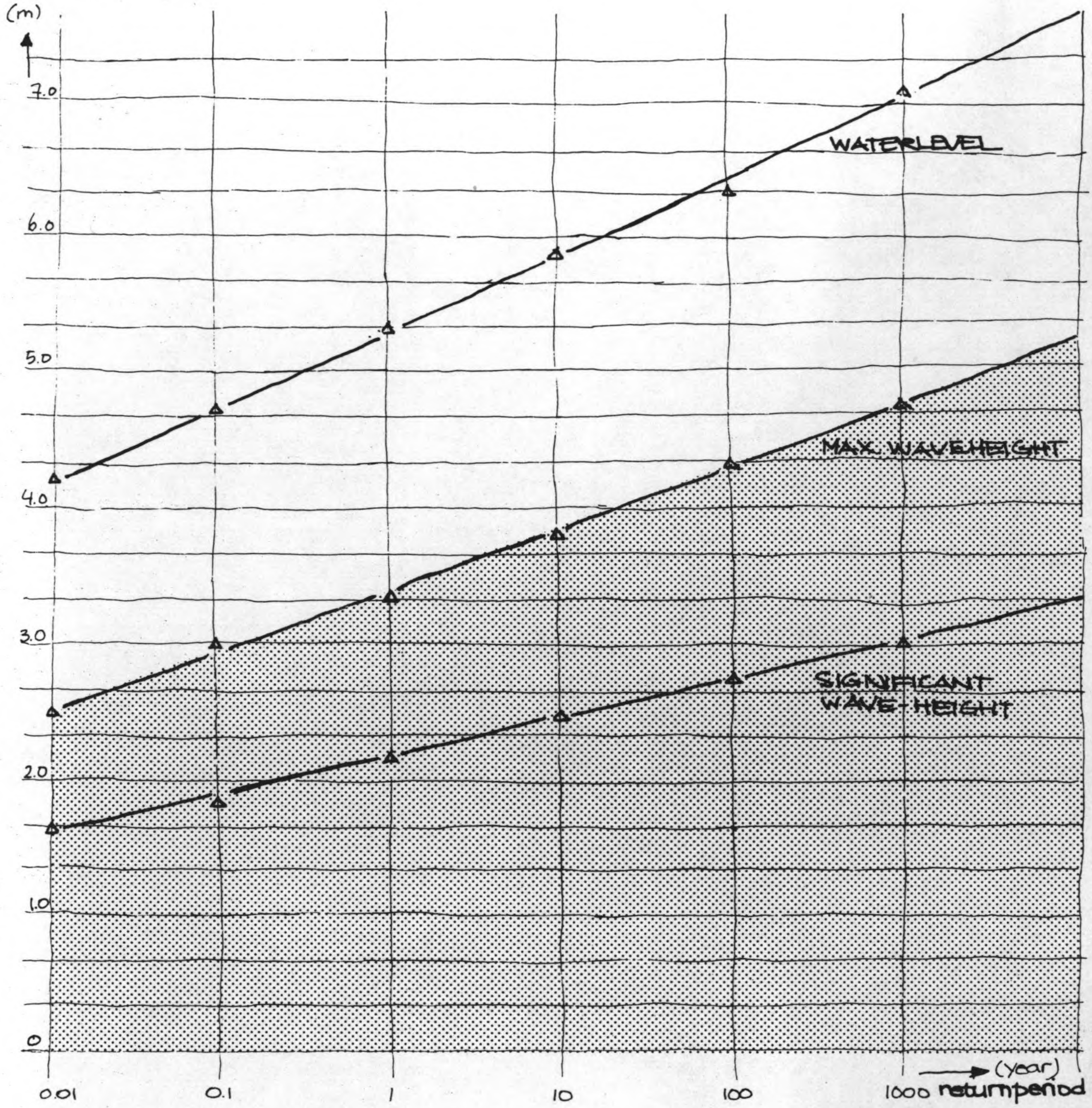
H_s = significant wave-height [m]
d = waterdepth [m].

The maximum wave-height is also dependent on the waterdepth, determined by the breaking-criterion (see Fig. 0.3):

$H_{max} = 0.78\ d$ ....(6)

H_{max} = maximum wave-height [m].

During severe storms (typhoons) this maximum wave-height will almost certainly occur, therefore it should be considered a design-criterion for the construction.



(m)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
WATERLEVEL
MAX. WAVEHEIGHT
SIGNIFICANT
WAVE-HEIGHT
0.01
0.1
1
10
100
1000
(year)
returnperiod

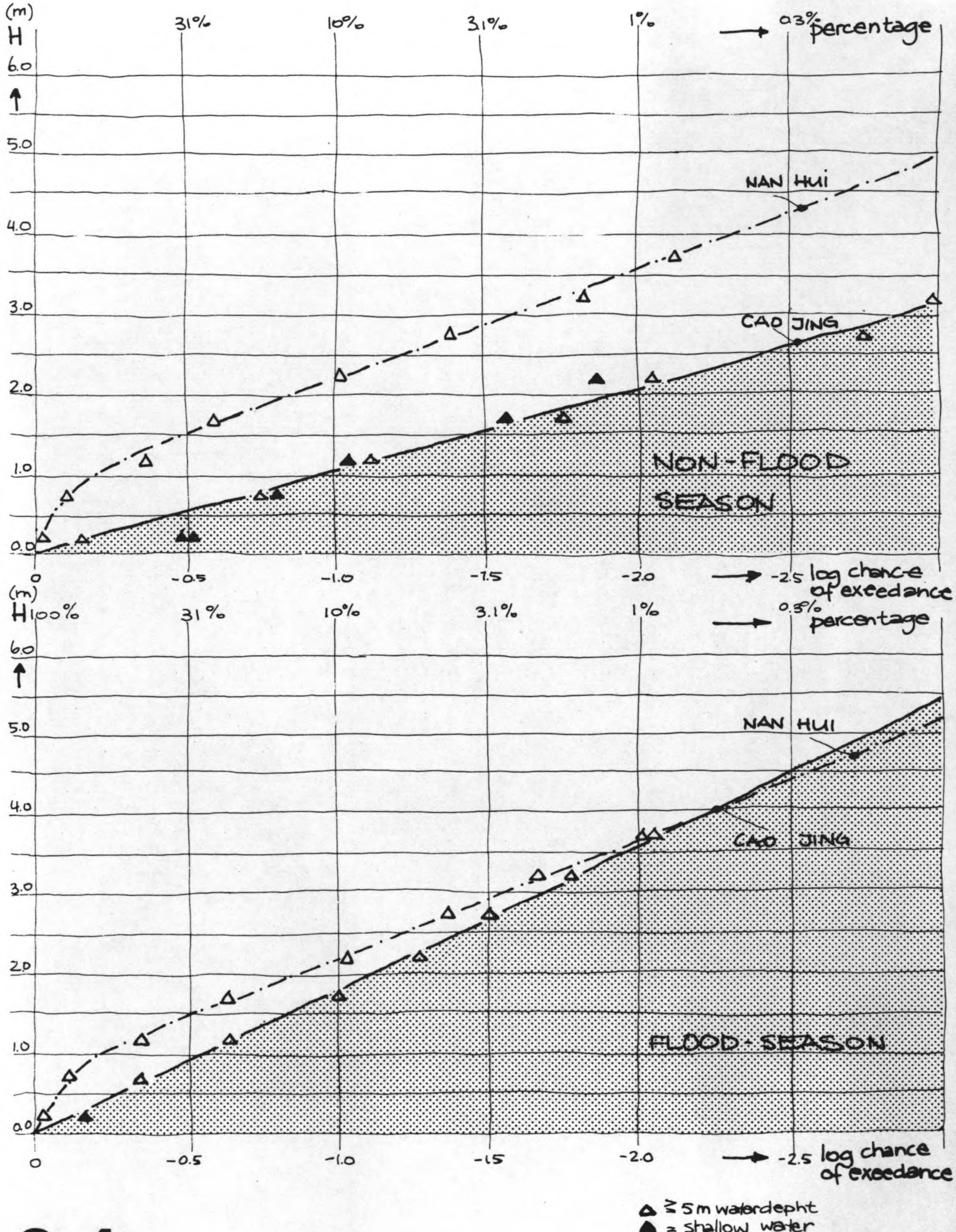
0.3 The wave-climate at the Cao Jing district

Measurements of waves and wind-speeds are available at Cape Nan Hui Zui (30° 5' N 122° 3' E).
These data have been used to calculate the wave-heights and wave-periods at Cao Jing (taking into account shoaling, refraction and the generation of waves by wind).
The results are shown in Fig. 0.4, for a waterdepth of more than 5 m. If the waterdepth is less, the distribution is broken off, since the maximum wave-height is limited by the breaking-criterion (see eq. (6)).

Fig. 0.4 concerns the long-term distribution of wave-heights (during "normal" conditions). In case of an extreme storm the distribution of the wave-heights can't be found from Fig. 0.4, since then the waves follow a Rayleigh-distribution, with a significant wave-height determined by the waterdepth, as shown in par. 0.3.

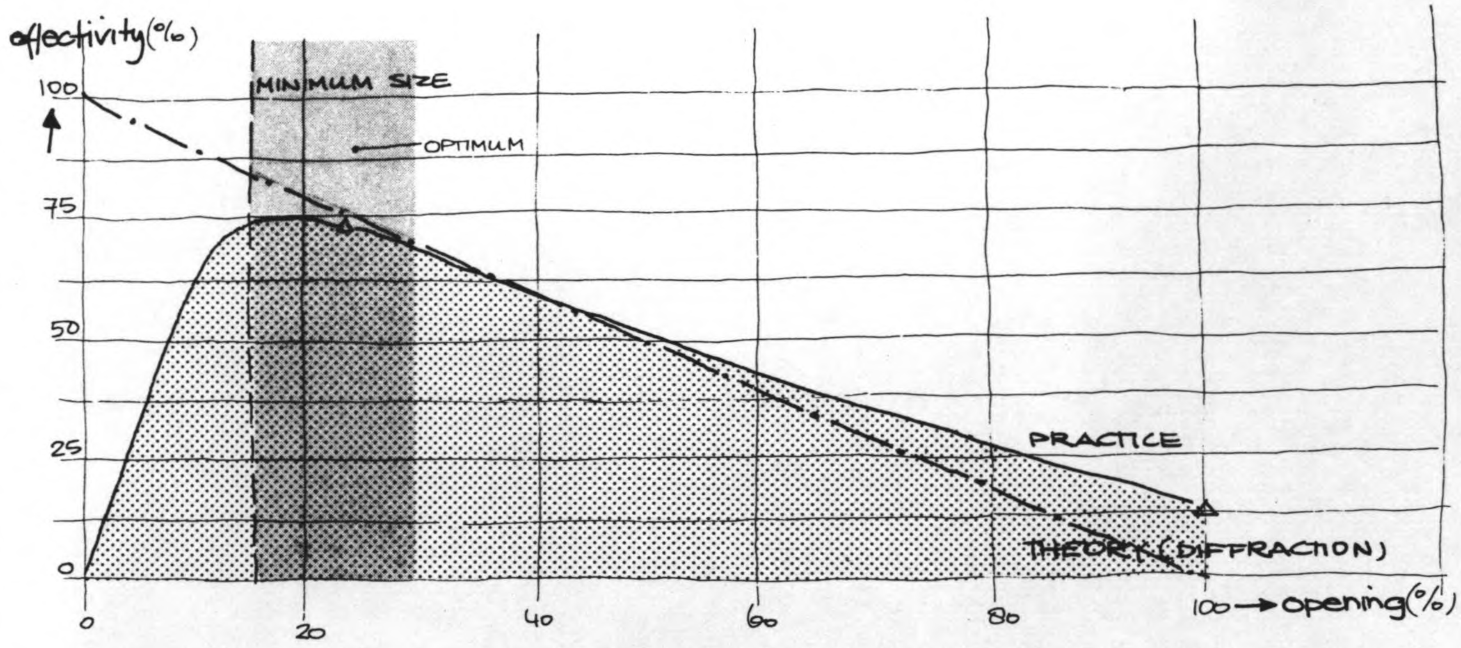
0.4 Lay-out design

A relation between the size of the opening and the wave-action inside the reclamation has been determined, calculated according to the diffraction theory (see Fig. 0.5).
Also a relation between the dimensions of the fields and the wave-action caused by wind-generation.
This results in a maximum allowable fetch-length of the fields (see Fig. 0.5).
The height of the dike is also influencing the wave-action inside the fields, an optimum height can be determined by a calculation of the wave-transmission (see Fig. 0.5).

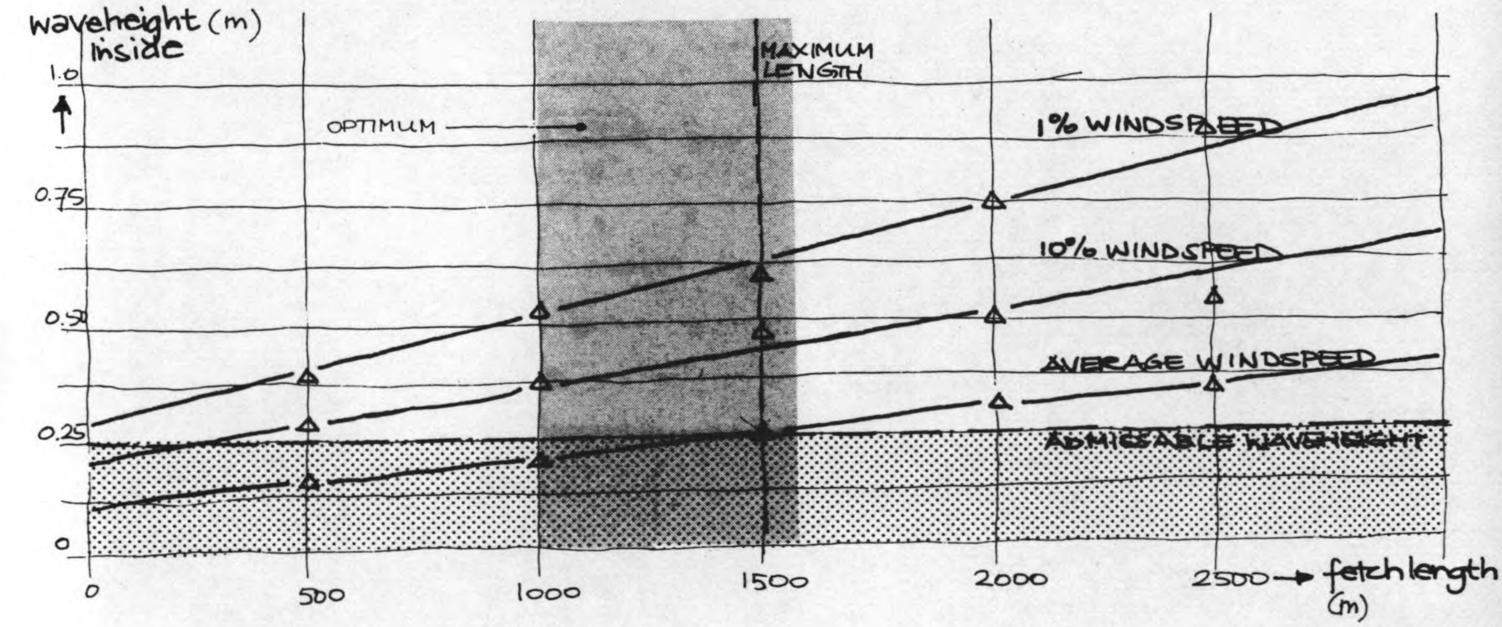


(m)
H
6.0
5.0
4.0
3.0
2.0
1.0
0.0
31%
10%
3.1%
1%
0.3%
percentage
NAN HUI
CAO JING
NON-FLOOD SEASON
0
-0.5
-1.0
-1.5
-2.0
-2.5
log chance of exeedance
(m)
H
100%
31%
10%
3.1%
1%
0.3%
percentage
6.0
5.0
4.0
3.0
2.0
1.0
0.0
NAN HUI
CAO JING
FLOOD-SEASON
0
-0.5
-1.0
-1.5
-2.0
-2.5
log chance of exeedance
≥ 5 m waterdepht
= shallow water

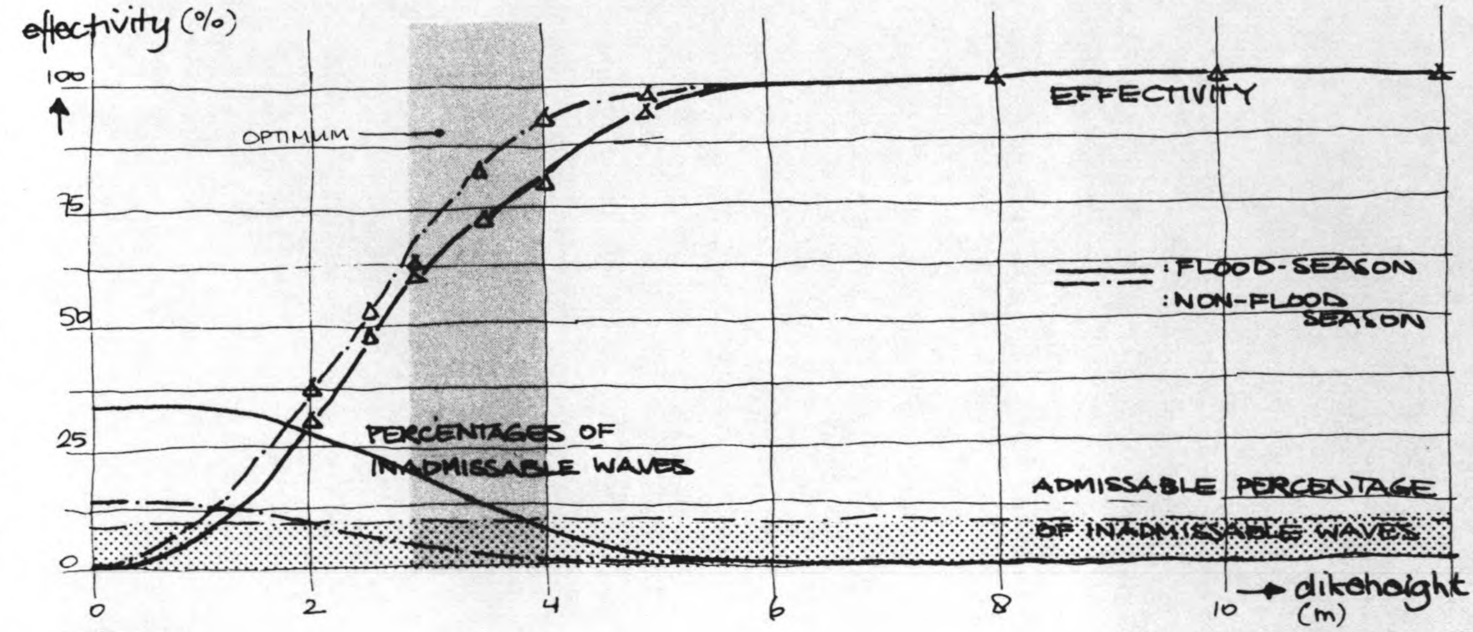
0.4



effectivity(%)
100
75
50
25
0
MINIMUM SIZE
OPTIMUM
PRACTICE
THEORY (DIFFRACTION)
0
20
40
60
80
100 → opening(%)



waveheight (m)
inside
1.0
0.75
0.50
0.25
0
MAXIMUM
LENGTH
OPTIMUM
1% WINDSPEED
10% WINDSPEED
AVERAGE WINDSPEED
ADMISSABLE WAVEHEIGHT
0
500
1000
1500
2000
2500 → fetchlength
(m)



effectivity (%)
100
75
50
25
0
OPTIMUM
EFFECTIVITY
: FLOOD-SEASON
: NON-FLOOD SEASON
PERCENTAGES OF
INADMISSABLE WAVES
ADMISSABLE PERCENTAGE
OF INADMISSABLE WAVES
0
2
4
6
8
10 → dikeheight
(m)

0.5

Summarizing the optimum lay-out design can be described (see Fig. 0.6):

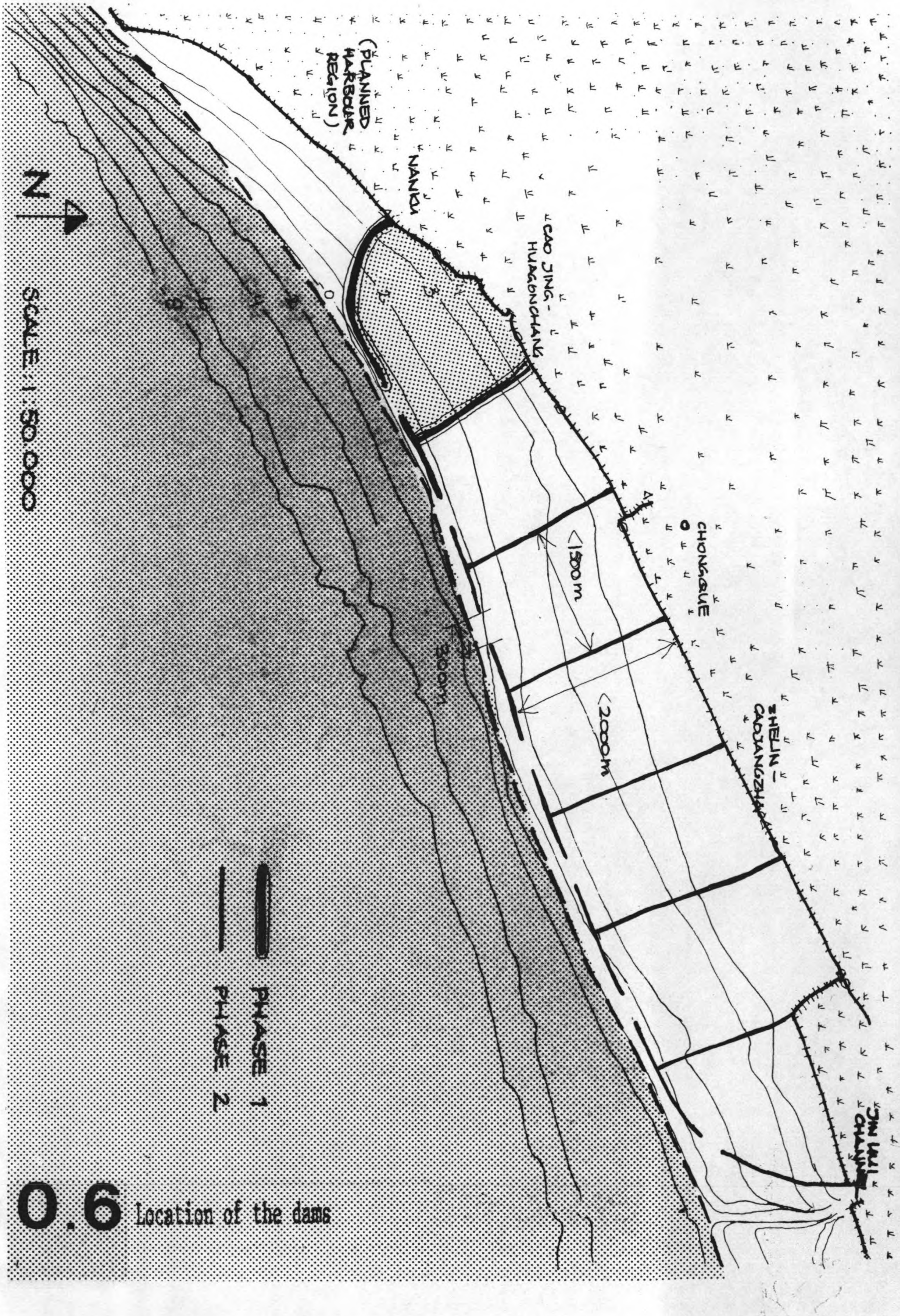
- opening-width of the fields about 300 m, with a small threshold in the opening. The height of the threshold should increase with the rising bottom-level of the basins;

- distance between the cross-dams about 1,500 m, in order to create a basin of which the length-distance ratio is about 1:1;

- length of the fields at a maximum of 2,000 m, the longitudinal dike should not be constructed at a deeper level than the 1+ bottom-level, unless the project is carried out in more stages (the first longitudinal dike at +2 m, the second at +0 m or -1 m);

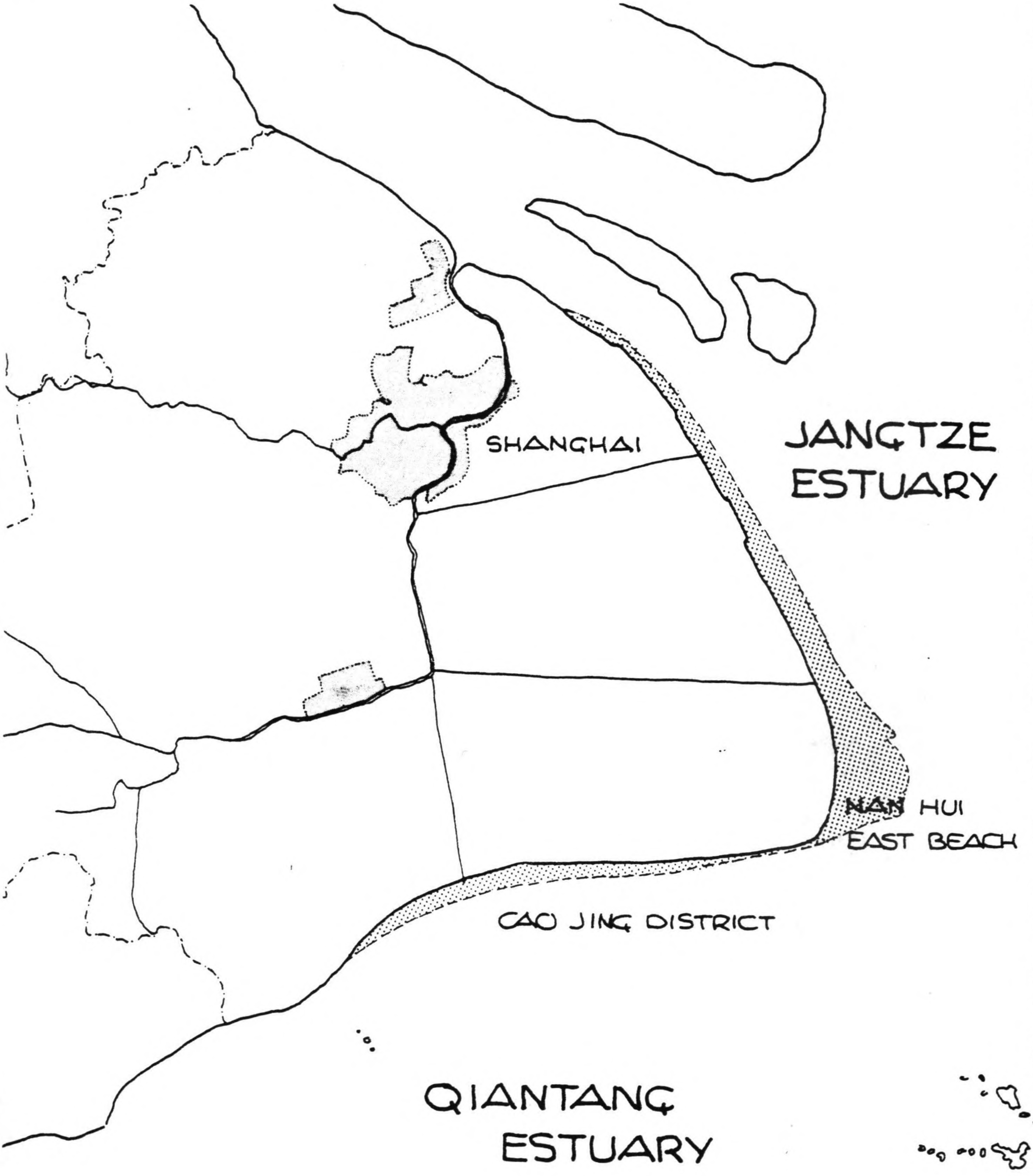
- the height of the (longitudinal) dike about 3.50 m, so that the top of the dike is situated at +4.50 m (Wusong-level);

- the expected sedimentation will be in the order of the "storage quantity" (see LAY-OUT part 1 (lit (12)).
  A rise of the bottom-level of 1.5 m during the first year.



0.6 Location of the dams

Content



1.1
Overview of the area

1. INTRODUCTION

1.2 Problem

In the delta of the Yangtze river and the Hangzhou-bay a reclamation project is being prepared concerning particularly the Cao Jing district (see Fig. 1.1).

In a foregoing study "study about landreclamation" (lit. (17)) it was suggested tot apply a system of cross-dams and longitudinal dams in order to stimulate the natural accretion. These dams could consist of geotextile membranes filled with soil (see Fig. 1.2).

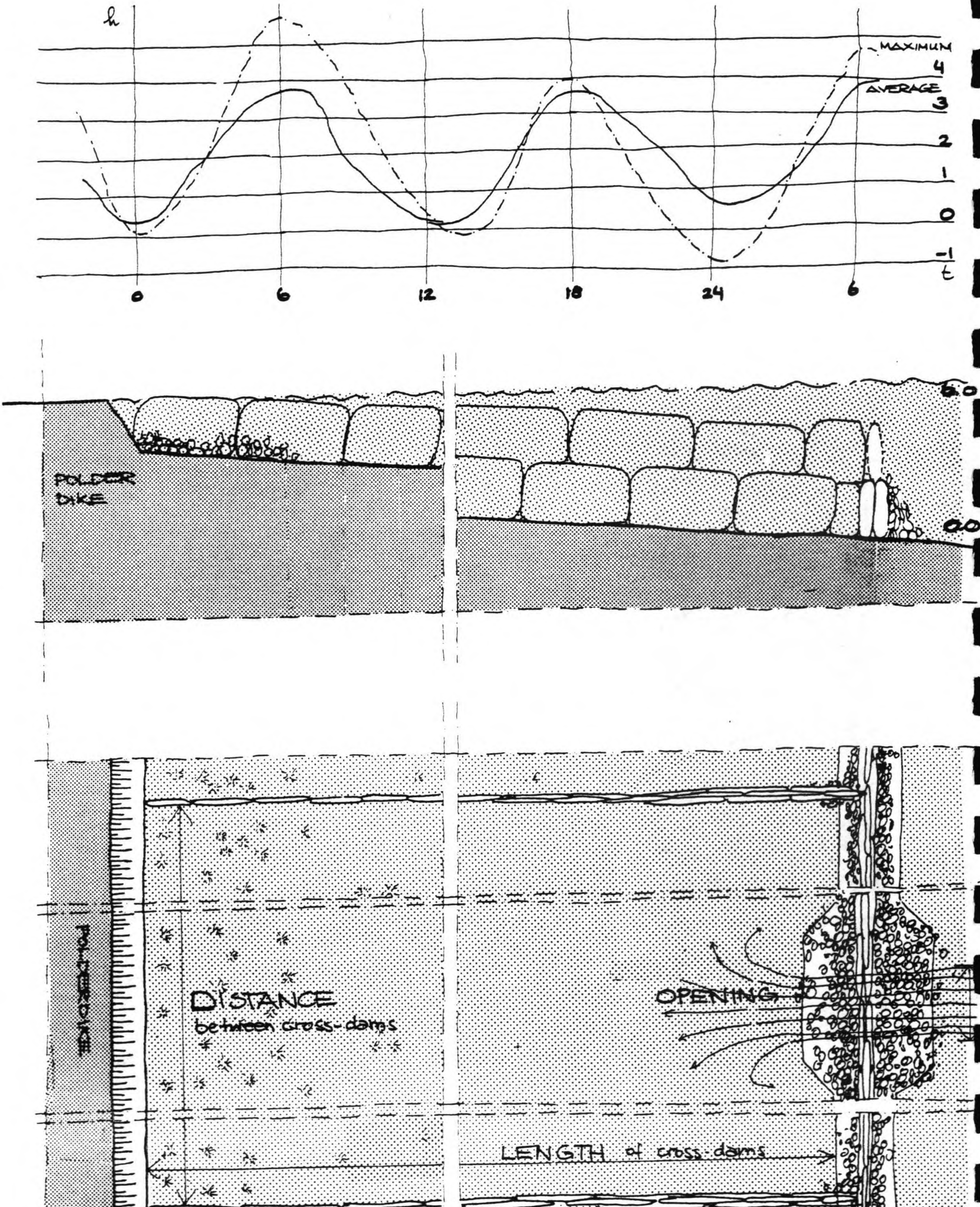
The next phase in this project is to perform a feasibility study resulting in a preliminary design of the landreclamation system. This study comprises the following items:

A. LAY-OUT : the location of the dams in relation to the expected sedimentation. Relations might be found between the rate of siltation and the total length of dams.

B. CONSTRUCTION DESIGN : the dimensions of the soil filled tubes, the kind of geotextile required to resist loadings caused by waves, wind, currents and tidal action.
A relation might be found between the total costs per m' cross-section and the chance of failure.

C. CONSTRUCTION METHOD : ways to fill and handle the tubes that they can be used as construction elements. An optimization might be possible concerning the total costs of the project related to the way of construction.

This report focusses on the first item: to determine a relation between the configuration of the dams and the rate of siltation. In the report "lay-out part I, tidal motion" (lit. (12)), the optimum lay-out with respect to the tidal influence has been discussed. Here the influence of the wave-climate is determined, also the requirements on the dam lay-out, i.e. the width of the openings and the height of the dams.



1.2

System of landreclamation

1.2 Approach

This report forms a complementary study on the subject of the relation between the lay-out of the reclamation-system and the accretion of sediments inside the system. In the report "Lay-out part I" it has been discussed the optimum lay-out in case only the storage inside the fields by the tidal motion and the long-shore current along the area is taken into account (the two mechanisms are suspected to form the major instruments of transportation of sediments into the reclamation-area). In this analysis, the wave-climate is calculated at the projected construction-trace and the effect of waves on an optimum solution for the lay-out of cross-dams and longitudinal dams is discussed.

The main conclusions from the foregoing study are:

- opening-size at the seaward end as large as possible;
- length of the fields as short as possible (in the order of 500 m);
- distance between the cross-dams as large as possible (in the order of 1,000 m).

It is expected that the influence of the waves gives rise to the following requirements:

- opening-size at the seaward end as small as possible;
- length of the fields and distance between the cross-dams dependent on the maximum allowable fetch-length which causes the maximum admissable waves inside the reclamation fields;
- height of the (longitudinal) dams dependent on the maximum admissable transmission of waves inside the reclamation-fields.

In this report, first the wave-climate at the Cao Jing district is calculated, based on the refraction-shoaling calculation of measurements at Cape Nan Hui (chapters 2 and 3).

Next the admissable wave-action inside the reclamation fields is calculated. The opening-size of the fields is related to wave-diffraction; the dimensions of the fields are related to the growth of waves and wind; the height of the dams is related to the transmission of waves into the fields. Considering the admissable wave-action this results in requirements on opening-size, dimensions and dike-height (chapter 4).

Chapter 5 describes the criteria which will result in a chosen lay-out design plus the consequences for the construction: design-level and design-wave.

2. THE WATER-LEVEL AT THE CAO JING DISTRICT

2.1 General

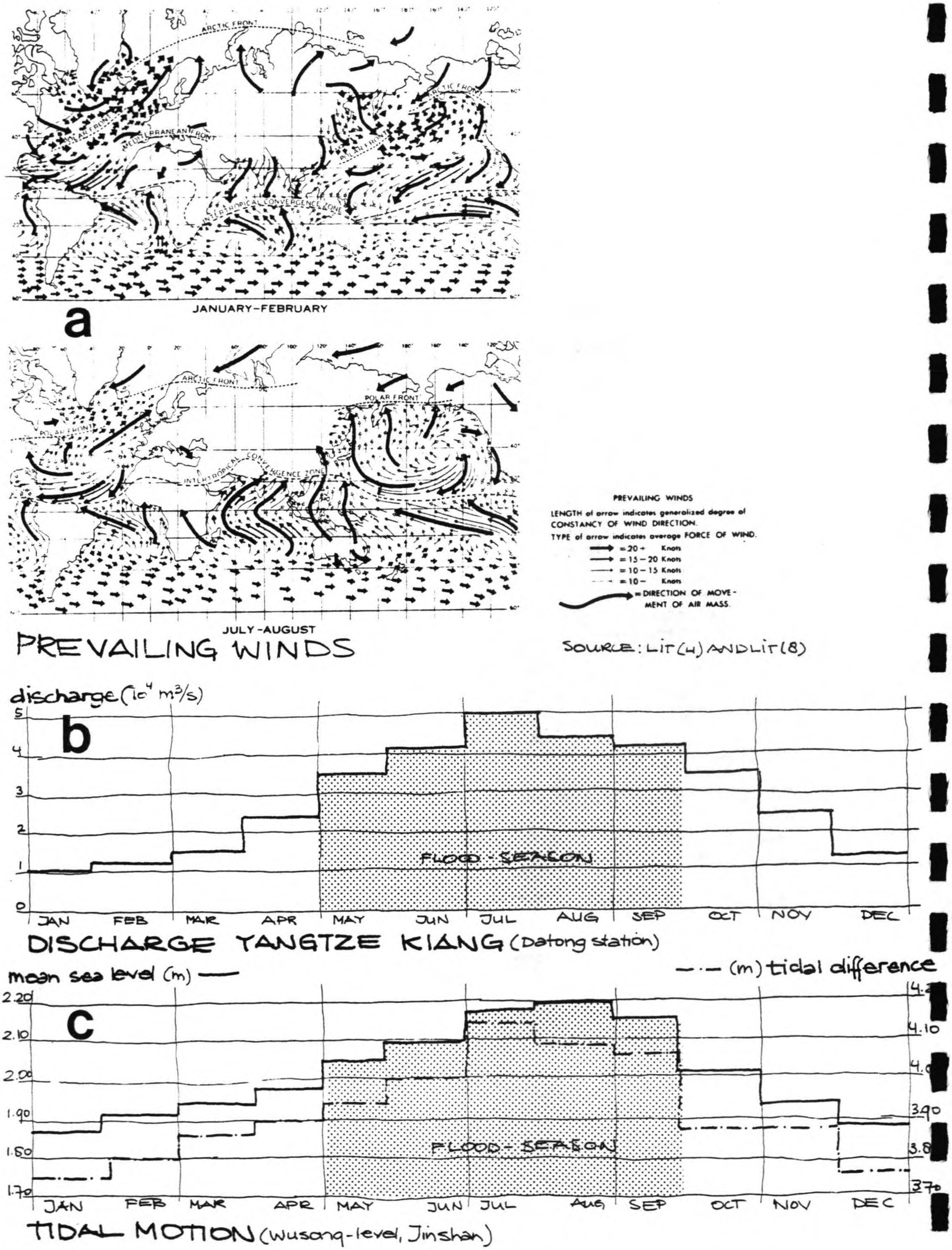
In order to determine the wave-climate at the Cao Jing district, especially the extreme waves, it is important also to know the distribution of the water-level.

The landreclamation-area is situated along the coast of the Yangtze-estuary and the Qiantang estuary (see Fig. 1.1). During the year it exists a considerable difference between the average water-level in the "dry season" (October-April) and the "flood-season" (May-September). During the flood-season the discharge of the Yangtze river is much increased, also the prevailing wind-direction along the coast of East-China is south-south-east (see Fig. 2.1). These two effects cause an increased tidal amplitude, an increase of the average water-level, and an increased wave-action along the coast (see lit. (7), lit. (8), lit. (23)).

Since the circumstances during the non-flood season and flood season are so much different, it is wise to make a distinction between the distribution of the occurence of high levels and waves during flood season and non-flood season.
Table 2.1 shows the condition during flood season and non-flood season (data originating from lit. (2), (3), (4), (5)).

	Non-flood season	flood season
- months number	October-April 7	May-September 5
- prevailing wind-direction	N-NE	S-SE
- tidal difference LW (average) HW (average)	3.90 m -0.20 m +3.70 m	4.20 m +0.10 m +4.30 m
- mean sea level	+1.90 m	+2.20 m
(Wusong level)		

Table 2.1: average circumstances during the year at the Cao Jing district



2.1 Flood season and non-flood season

2.2 Distribution of the water-level

The tidal motion at the Cao Jing district consists of a semi-diurnal movement with an average period of 44,700 s (700 tides per year).
Schwiderski (lit. (19), (20), (21)) and others (lit. (23), (2), (3), (4), (5)) found that the M_2-component is the far most important component which dertermines the tidal motion.
In table 2.2 a comparision is given of the amplitudes of the important tidal components.

Nan Hui	M_2	S_2	O_1	K_1	M_4	MS_4	$\frac{M_2 + S_2}{O_1 + K_1}$	$\frac{M_4}{M_2}$
Amplitude (m)	1.58	0.63	0.19	0.28	0.12	0.9	5	0.07

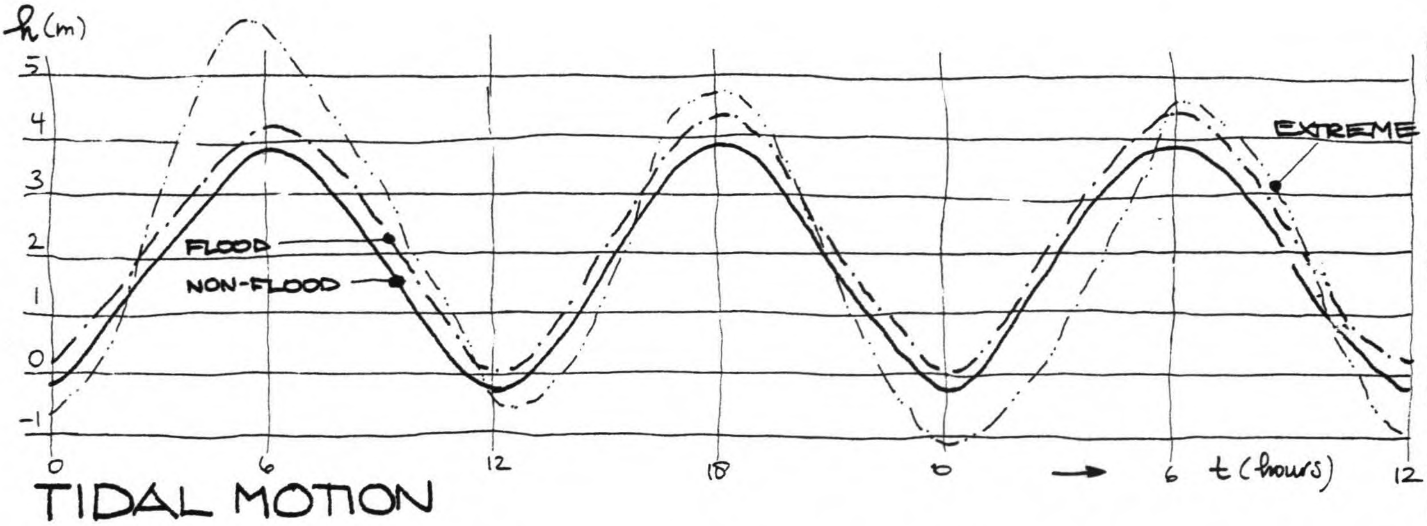
Table 2.2: amplitudes of tidal components at Nan Hui

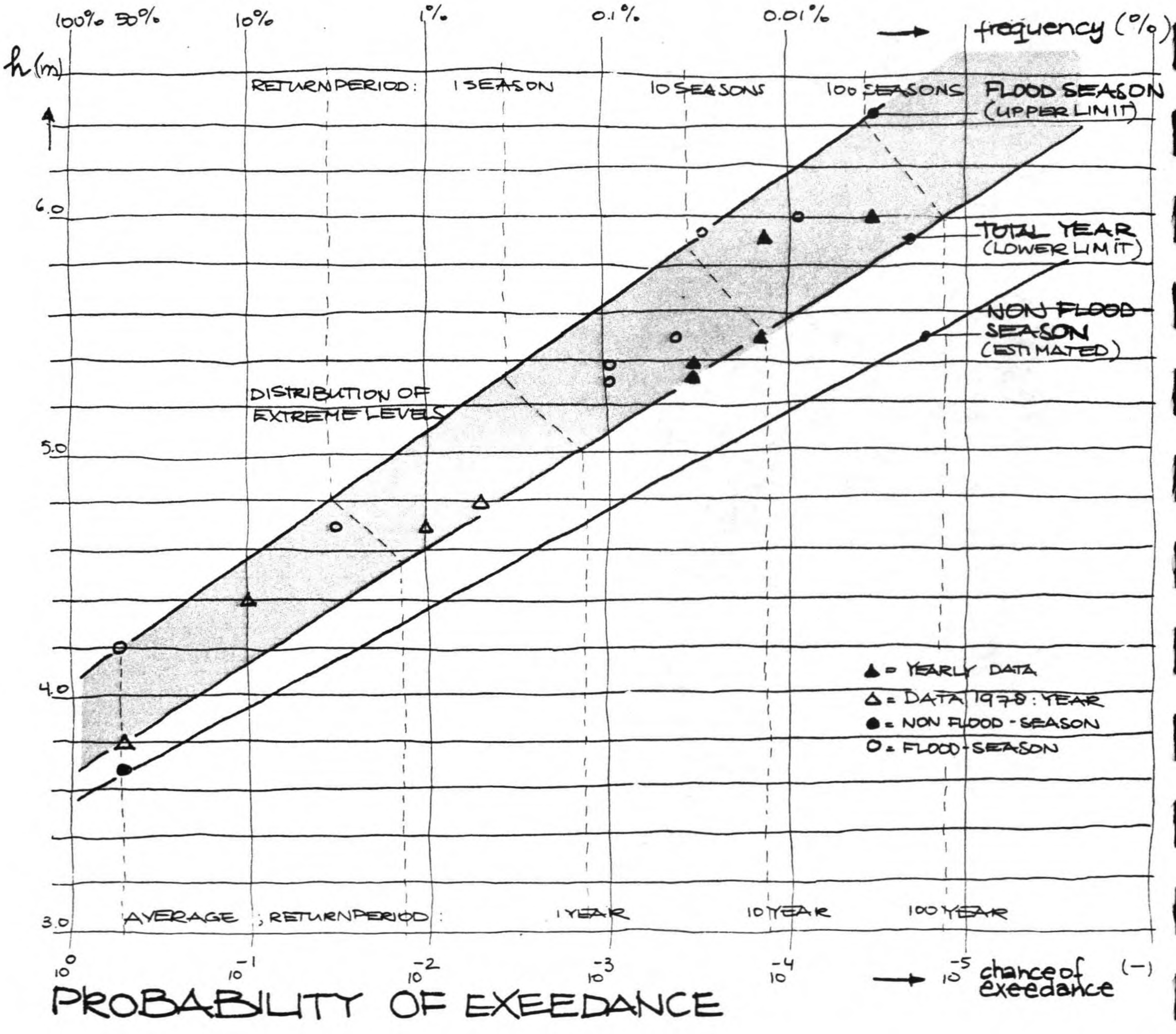
Thus the tidal motion can be described as a wave with a period of 44,700 s (the second extreme during the day is only slightly lower than the first extreme) and an amplitude dependent on the season (see table 2.1).

The extreme water-levels at the Cao Jing district are supposed to follow an exponential distribution. The high levels occur twice a day (700 times per year), following data (table 2.3) can be found in lit. (2), (3), (4) and (5).

Wusong level	year	non-flood season	flood season
<u>High-water</u>			
- average	+3.90	+3.70	+4.20
- 31-8-1981			+5.31 (Cao)
- in ten years (20-8-1974)			+5.93 (Jin Shan)
- ever recorded			+5.98 (Jin Shan)
- return period 10 years	+5.54 (Cao)		
- return period 5 years	+5.37 (Cao)		
<u>Low-water</u>			
- average	-0.10	-0.20	+0.10
- 31-8-1981			-0.61 (Cao)
- in ten years (5-4-1969)		-1.78 (Jin Shan)	
- ever recorded		-1.78 (Jin Shan)	

Table 2.3: some data about the occurrence of extreme water-levels





2.2

Distribution of extreme water-levels at Cao Jing

Also a graph is given in lit. (2) of the cummulative frequency of high-water-levels during 1978.

All these data can be used to approximate the long-term distribution of the water-level at Cao Jing district.
The distribution is expected to be an exponential distribution:

$$p\ (h \geq \underline{h}) = \exp \frac{-\underline{h} - a}{b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The values of a and b can be calibrated by a graphical interpretation of the data. If the long-term distribution is in fact the exponential distribution, the data should show a straight line if they are presented on a semi-logarithmic scale (i.e.: a linear scale for the water-level h and a logarithmic scale for the chance of occurrence).

The interpretation of the data (see Fig. 2.2)

- Average values: since $p\ (h \geq \underline{h}) = 0.5$ this chance can be directly transferred to the graph (see Fig. 2.2).

- Values 31-8-1981: this date belongs to the flood season, and it is supposed that it is the highest recorded level in the past 5 years. It exists 700 tides per year, of which 271 belong to the flood season. So the total number of events during 5 years: N = 1,355.
  Since this event took place only once; we can suppose the chance of occurrence:

  $p\ (h \geq 5.31) = 1/1{,}355 = 7.4.10^{-4}$ (flood season).

  If we recalculate this chance for the total year, the total number N = 3,500, thus the chance would be:

  $p\ (h \geq 5.31) = 1/3{,}500 = 2.86.10^{-4}$ (total year).

- Values in 10 years: the value of 20-8-1974 also belongs to the flood season. The period of recording this level took 10 years and we can counter this level the highest measured in 10 years. For the flood season, this means N = 2,710:

  $p\ (h \geq 5.93) = 1/2{,}710 = 3.69.10^{-4}$ (flood season).

  For the total year: N = 7,000:

  $p\ (h \geq 5.93)\ 1/7{,}000 = 1.43.10^{-4}$ (total year).

- Value with a return period of 10 years: the maximum levels can be expected to occur during the flood season (minimum levels during the non-flood season). Since the expected distribution is an exponential distribution, following expression is valid for the value with a return period of 10 years:

  $$1 - (1 - p\ (h \geq h_{10}))^N = 0.63 \qquad (2)$$

  in which N is the number of events. The return period appoints the level of which the probability of occurring once during the return period is maximal (see lit. (10)). For the flood season curve the number of events N = 2,710, thus the chance of occurrence (using eq. (2)):

  $p\ (h \geq 5.54) = 3.67.10^{-4}$ (flood season).

  For the total year, N = 7,000 and the chance:

  $p\ (h \geq 5.54) = 1.42.10^{-4}$ (total year).

- Value with a return period of 5 years: again this level can be expected to occur during the flood season. Now following expression is valid (taking into account an exponential distribution):

  $$1 - (1 - p\ (h \geq h_5))^N = 0.63 \qquad (3)$$

  For the flood season the number of events during 5 years is N = 1,355; using eq. 3:

  $p\ (h \geq 5.37) = 7.33.10^{-4}$ (flood season).

  For the total year N = 3,500 and

  $p\ (h \geq 5.37) = 2.84.10^{-4}$ (total year).

For the non-flood season only the average value is known, with respect to the probability of exceedance curve. Since we are interested to find the design wave and the design-level, only the maximum tidal levels are important (during low-water the construction is situated in the dry - no waves are present). The data of 1978 are also presented in Fig. 2.2, they seem largely in agreement with the data so far.

The interpretation of the distribution (see Fig. 2.3)

According to Fig. 2.2 there is not one explicit line which can be drawn through all of the data-points. Apart from that there is a considerable uncertainty in the assumed "return period" of the data (or the number of events).

Also Fig. 2.2 shows that it makes a considerable difference if one refers the data to the flood season only, or the total year. In fact it would be right to refer to the flood season, since the extreme levels only occur during the flood season. (In Fig. 2.2 the probability of exceedance which belongs to a certain return period is different for the flood season and for the total year. This is due to the difference in number of events during a return period.)
However, usually one refers to a return period with respect to the total year. Therefore we can consider the "total year"-line in Fig. 2.2 a lower limit of a realistic distribution and the "flood season"-line as an upper limit.

Because of a lack of data, the upper limit is chosen to be used for the most probable distribution of the water-level. This distribution is supposed to be an exponential distribution; calibration of the constants a, b (eq. 1) to Fig. 2.3 results in the following expression for the chance of occurrence:

$$p\ (h \geq \underline{h}) = e^{-4.1\ (\underline{h}\ -\ 3.75)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

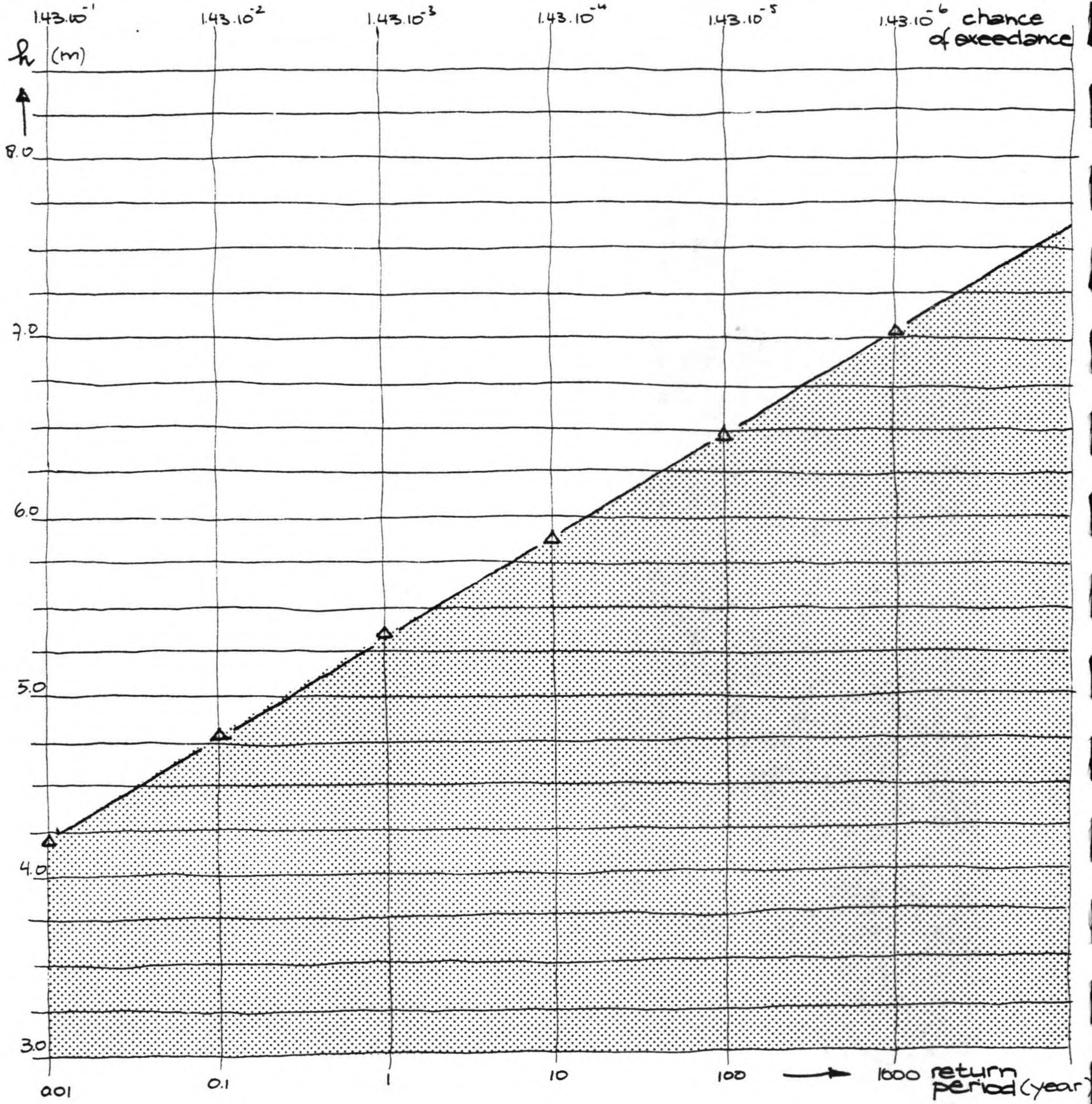
The average values of the water-level during the year:

high-water : +4.0 m;
low-water : -0.0 m.

The water-levels follow a tidal motion with a period of 44,700 s, 700 tides per year. Table 2.4 shows the time during which the water-level remains between certain levels (average tidal motion) during the day:

water-level	non-flood	flood
< 1.5 m (1)	8.2 hours	9.8 hours
1.5 - 2.5 m (2)	4.3 hours	3.3 hours
2.5 - 3.5 m (3)	5.2 hours	4.4 hours
3.5 - 4.5 m (4)	6.3 hours	4.0 hours
4.5 - 5.5 m (5)	extreme	2.5 hours
5.5 - 6.5 m (6)	extreme	extreme

Table 2.4: average duration of water-level intervals during the day



2.3

Return-period of extreme water-levels at Cao Jing

CONCLUSION

With respect to the water-level at the Cao Jing district, a distinction can be made between:

- flood season: the discharge of Yangtze Kiang is large, the prevailing wind direction is south.
  Wave-action is more pronounced than during the non-flood season, tidal levels are higher.
  During: MAY, JUNE, JULY, AUGUST, SEPTEMBER.

- Non-flood season: moderate discharge of Yangtze Kiang, the prevailing wind direction is north.
  Wave-action is moderate (wind from landside), tidal action is also moderate.
  During: OCTOBER, NOVEMBER, DECEMBER, JANUARY, FEBRUARY, MARCH, APRIL.

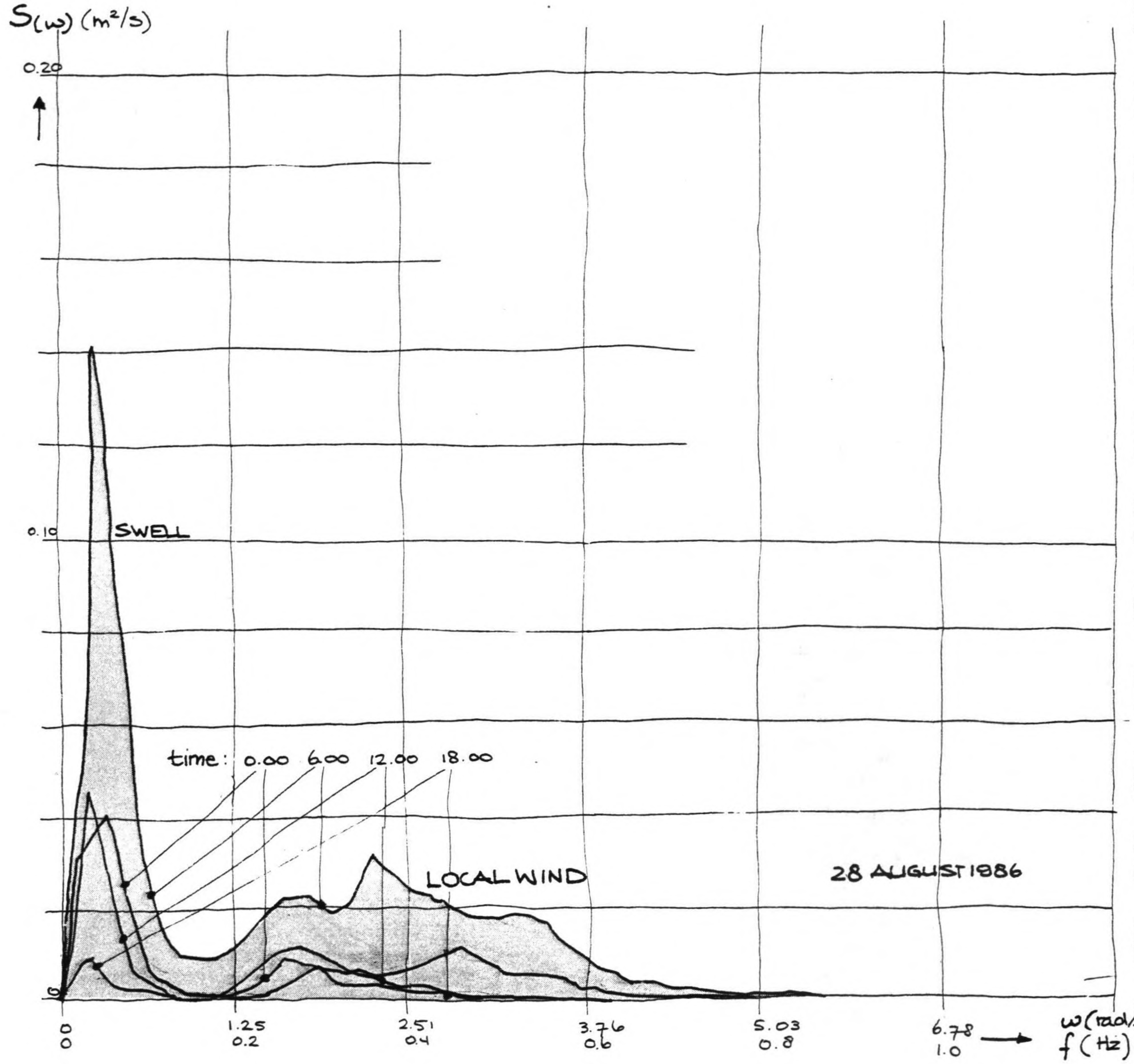
For the tidal motion during the year following is valid:

water-level	non-flood season	flood season
< 1.5 m (+1)	8.2 hours	9.8 hours
1.5 - 2.5 m (+2)	4.3 hours	3.3 hours
2.5 - 3.5 m (+3)	5.2 hours	4.4 hours
3.5 - 4.5 m (+4)	6.3 hours	4.0 hours
4.5 - 5.5 m (+5)	extreme	2.5 hours
5.5 - 6.5 m (+6)	extreme	extreme

Table 2.4: average duration of water-level intervals during the day

The extreme high water-levels occur during the flood season, due to extreme strong wind (typhoon-conditions).
Referred to the year the long-term water-level follows an exponential distribution (see Fig. 2.3)

$$p\,(h \geq \underline{h}) = e^{-4.1\,(\underline{h}\,-\,3.75)} \qquad \ldots\ldots (4)$$



3.1

Typical wave-spectra at Cao Jing

3. THE WAVE CLIMATE AT THE CAO JING DISTRICT

3.1 General

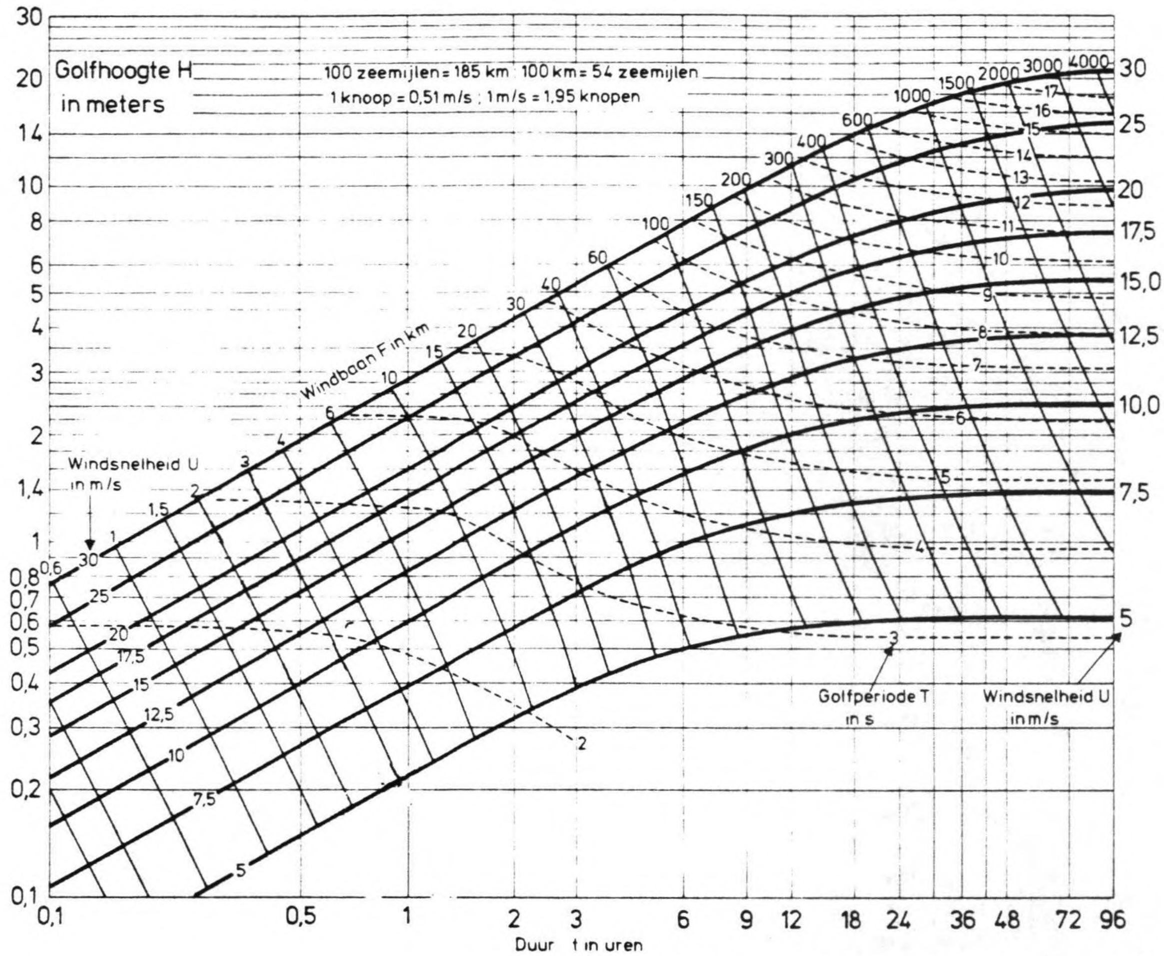
The waves at the Cao Jing district are caused either by the wind directly at the area (wind-waves) or by the windfields in areas further away, transported through the water towards the coast of the Cao Jing district (swell). Fig. 3.1 shows some typical spectra of the waves at the coast of Cao Jing.

So, in order to determine the wave climate at the Cao Jing district, it is necessary to know following data:

- the water-level distribution at the coast;
- the bottom-topography at the coastal zone;
- the wind-distribution at the coastal zone;
- the wave-height and wave-period data at a point not too far away.

By a refraction and shoaling calculation, the wave-height can be recalculated to fit the Cao Jing coast (on-shore wind-direction) or the wave height can be calculated by the expected wind-growth (off-shore wind-direction), when taking into account the bottom-topography and the waterdepth.

From the K.N.M.I. (lit. (7), (8)) measurements at Cape Nan Hui Zui (31° N, 122° E) of waveheights, wave-periods and wind-speed plus direction are available.



SOURCE: GROEN EN DORRESTEIN, LIT(H)

3.2

Representative wave-period

3.2 The wave climate at Cape Nan Hui Zui

From measurements (lit. (8)), see Appendix A, data in each month of the year are available. These data concern:

- wind-speed from eight directions divided in classes of 5 m/s;
- wave-height during the above mentioned wind divided in classes of half a meter;
- wave-period against wave-height per month.

The missing information concerns the wave-period representative for each class of wind-speed and wave-height. This representative wave-period can be found from Groen en Dorrestein (lit. (14)), see Fig. 3.2.
The graph shows the relation between the wave-height, the wind-speed and the wave-period. For example, if the wind-speed is U = 5-10 m/s and the wave-height is H = 0.25-0.75 m, the wave-period will be T = 2-3 s.
This wave-period can be checked by an equation given in the shore-protection manual (lit. (6)), which is valid for waves in wind-fields at open sea:

$$\bar{T} = 3.94\ H_s^{0.376} \qquad (5)$$

in which
H_s = significant wave-height (m), in this case the height of the wave-class
$\bar{T}$ = representative wave-period (s).

The following pages show the rearanged data from Appendix A, concerning the measuring-point (Cape Nan Hui Zui), and for the flood-season (May-September) and the non-flood season (October-April) table 3.1a to 3.1p). In this table, the directions concern the <u>wave</u>-direction (which is supposed to be comparable to the wind-direction).

N.B. The point of measurements, Cape Nan Hui Zui (30.5° N and 122.3° E) is about 100 km away from the coast of Cao Jing, in eastward direction. The waterdepth at this point is 15-20 m (dependent on the tidal level).

NON-FLOOD SEASON

N	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave- height (m)				(wave-period(s))				
<0.25	1.47 (2)	1.91 (2)	*					3.39
0.25-0.75	0.14 (2.8)	4.39 (2.8)	1.93 (2)	* (2)				6.45
0.75-1.25	* (4)	3.04 (4)	7.81 (3.5)	0.14 (3.0)				10.99
1.25-1.75		0.41 (5)	4.85 (5)	1.56 (4)			0.06 (9)	6.84
1.75-2.25			2.46 (6)	1.83 (5)	0.17 (5)		0.41 (9) 0.12 (11)	4.98
2.25-2.75			0.43 (6)	1.42 (5)			0.29 (11)	2.13
2.75-3.25			0.32 (7)	0.47 (6)			0.12 (11) 0.12 (13)	1.03
3.25-3.75					0.35 (6)			0.35
3.75-4.75					0.35 (7)			0.35
4.75-5.75							0.20 (11)	0.20
TOTAL	1.61	9.75	17.8	4.95	0.87		1.31	36.71

Table 3.1.a: wave-height and wave-period against wind-speed, in percentages of occurrence during the non-flood season

NON-FLOOD SEASON

NE	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.38 (2)	1.10 (2)	0.16 (2)					2.05
0.25-0.75	0.20 (2.8)	2.67 (2.8)	1.02 (2)					3.89
0.75-1.25		1.76 (4)	4.70 (3.5)	0.16 (0)				6.63
1.25-1.75		0.90 (5)	3.52 (5)	0.26 (4)				3.86
1.75-2.25			1.27 (6)	1.42 (5)			0.25 (9) 0.07 (11)	3.01
2.25-2.75				0.98 (5.5)			0.17 (11)	1.32
2.75-3.25				0.48 (6)				0.48
3.25-3.75			0.21 (7)					0.21
3.75-4.75				0.21 (8)				0.21
4.75-5.75								
TOTAL	0.58	6.43	10.9	3.51			0.49	21.90

Table 3.1.b: wave-height and wave-period against wind-speed, in percentages of occurrence during the non-flood season

NON-FLOOD SEASON

E	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.17 (2)	0.70 (2)	0.13 (2)					0.97
0.25-0.75		1.39 (2.8)	0.36 (2)	0.08 (2)				1.84
0.75-1.25		1.07 (4)	1.52 (3.5)	0.55 (3.0)				3.13
1.25-1.75		0.55 (5)	0.78 (5)	0.60 (4)				1.93
1.75-2.25		0.52 (6)		0.75 (5)			0.12 (9)	1.39
2.25-2.75				0.52 (5)				0.52
2.75-3.25				0.23 (6)			0.23 (11)	0.46
3.25-3.75								
3.75-4.75								
4.75-5.75								
TOTAL	0.17	4.23	2.79	2.73			0.35	10.21

Table 3.1.c: wave-height and wave-period against wind-speed, in percentages of occurrence during the non-flood season

NON-FLOOD SEASON

SE	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.21 (2)	0.32 (2)						0.53
0.25-0.75		0.68 (2.8)	0.33 (2)					1.00
0.75-1.25	0.21 (4)	1.02 (4)	0.49 (3.5)					1.71
1.25-1.75		0.15 (5)	0.91 (5)					1.06
1.75-2.25		0.70 (6)					0.06 (9)	0.76
2.25-2.75			0.29 (6)					0.29
2.75-3.25				0.12 (6)				0.12
3.25-3.75								
3.75-4.75								
4.75-5.75								
TOTAL	0.42	2.87	2.02	0.12			0.06	5.43

Table 3.1.d: wave-height and wave-period against wind-speed, in percentages of occurrence during the non-flood season

NON-FLOOD SEASON

S	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)	(wave-period(s))							
<0.25		0.28 (2)	0.16 (2)					0.44
0.25-0.75		0.63 (2.8)	0.19 (2)					0.83
0.75-1.25		0.54 (4)	0.88 (3.5)					1.42
1.25-1.75			0.87 (5)					0.87
1.75-2.25			0.60 (6)				0.04 (9)	0.64
2.25-2.75			0.24 (6)					0.24
2.75-3.25								
3.25-3.75								
3.75-4.75								
4.75-5.75								
TOTAL		1.45	2.94				0.04	4.44

Table 3.1.e: wave-height and wave-period against wind-speed, in percentages of occurance during the non-flood season

NON-FLOOD SEASON

SW	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25		0.25 (2)						0.25
0.25-0.75	0.07 (2.8)	0.34 (2.8)	0.07 (2)					0.48
0.75-1.25		0.39 (4)	0.42 (3.5)					0.81
1.25-1.75			0.50 (5)					0.50
1.75-2.25			0.33 (6)				0.02 (11)	0.35
2.25-2.75			0.14 (6)					0.14
2.75-3.25								
3.25-3.75								
3.75-4.75								
4.75-5.75								
TOTAL	0.07	0.98	1.46				0.02	2.53

Table 3.1.f: wave-height and wave-period against wind-speed, in percentages of occurance during the non-flood season

NON-FLOOD SEASON

W	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)	(wave-period(s))							
<0.25		0.199 (2)						0.20
0.25-0.75		0.21 (2.8)	0.18 (2)					0.39
0.75-1.25		0.17 (4)	0.48 (3.5)					0.65
1.25-1.75		0.40 (5)						0.40
1.75-2.25		0.08 (6)	0.21 (6)					0.29
2.25-2.75			0.13 (6)					0.13
2.75-3.25								
3.25-3.75								
3.75-4.75								
4.75-5.75								
TOTAL		1.10	1.00					2.14

Table 3.1.g: wave-height and wave-period against wind-speed, in percentages of occurance during the non-flood season

NON-FLOOD SEASON

NW	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.21 (2)	0.92 (2)	0.21 (2)					1.33
0.25-0.75		1.40 (2.8)	1.14 (2)					2.53
0.75-1.25		0.87 (4)	3.51 (4)	0.25 (3)				4.32
1.25-1.75			1.75 (5)	0.93 (4)				2.66
1.75-2.25		0.23 (6)	0.87 (6)	0.45 (5)	0.21 (4.5)		0.16 (9)	1.91
2.25-2.75			0.49 (6)	0.23 (5)			0.11 (11)	0.83
2.75-3.25				0.31 (6)				0.31
3.25-3.75				0.14 (7)				0.14
3.75-4.75				0.14 (8)				0.14
4.75-5.75								
TOTAL	0.21	3.42	7.97	2.45	0.21		0.28	14.63

Table 3.1.h: wave-height and wave-period against wind-speed, in percentages of occurance during the non-flood season

FLOOD SEASON

N	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.70 (2)	0.24 (2)						0.94
0.25-0.75	0.22 (2.8)	1.78 (2.8)	1.24 (2)					3.27
0.75-1.25		0.31 (4)	3.30 (3.5)	0.33 (3)				3.94
1.25-1.75		0.20 (5)	2.09 (5)	0.53 (4)			0.16 (11)	2.98
1.75-2.25			0.64 (6)	0.81 (5)			0.05 (11)	1.50
2.25-2.75			0.16 (6)	0.37 (5)			0.08 (11)	0.61
2.75-3.25				0.24 (6)			0.07 (11)	0.31
3.25-3.75					0.14 (6)		0.07 (12)	0.21
3.75-4.75						0.08 (6)		0.08
4.75-5.75						0.04 (6)		0.04
TOTAL	0.92	2.53	7.43	2.28	0.14	0.12	0.43	13.92

Table 3.1.i: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season

FLOOD SEASON

NE	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)	(wave-period(s))							
<0.25	0.03 (2)	0.66 (2)						0.69
0.25-0.75	0.05 (2.8)	1.50 (2.8)	0.89 (2)					2.42
0.75-1.25		1.46 (4)	1.46 (3.5)					2.91
1.25-1.75			1.23 (5)	0.81 (4)			0.12 (11)	2.20
1.75-2.25			0.92 (6)	0.15 (5)			0.03 (11)	1.10
2.25-2.75			0.21 (6)	0.17 (5.5)			0.06 (11)	0.45
2.75-3.25				0.18 (6)			0.05 (12)	0.23
3.25-3.75				0.10 (7)			0.05 (12)	0.15
3.75-4.75					0.06 (7.5)		0.02 (13)	0.08
4.75-5.75					0.03 (7.5)		0.02 (13)	0.05
TOTAL	0.08	3.62	4.71	1.41	0.09		0.35	10.28

Table 3.1.j: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season

FLOOD SEASON

E	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.11 (2)	0.52 (2)	0.09 (2)					0.73
0.25-0.75	0.12 (2.8)	1.93 (2.8)	0.52 (2)					2.56
0.75-1.25		1.68 (4)	1.37 (3.5)					3.08
1.25-1.75			2.20 (5)				0.12 (11)	2.32
1.75-2.25			1.13 (6)				0.04 (11)	1.17
2.25-2.75			0.42 (6)				0.06 (11)	0.48
2.75-3.25			0.19 (7)				0.06 (12)	0.25
3.25-3.75			0.11 (7)				0.06 (12)	0.17
3.75-4.75				0.06 (7)			0.02 (13)	0.08
4.75-5.75				0.03 (7)			0.02 (>13)	0.05
TOTAL	0.23	4.13	6.03	0.09			0.38	10.88

Table 3.1.k: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season

FLOOD SEASON

SE	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave- height (m)				(wave-period(s))				
<0.25	0.35 (2)	0.58 (2)	0.04 (2)					0.97
0.25-0.75	0.16 (2.8)	2.78 (2.8)	0.44 (2)					3.38
0.75-1.25		2.11 (4)	1.98 (3.5)					4.07
1.25-1.75		0.18 (5)	2.64 (5)				0.16 (11)	3.07
1.75-2.25			0.28 (6)	1.21 (5)			0.05 (11)	1.54
2.25-2.75			0.29 (6)	0.26 (5)			0.08 (11)	0.63
2.75-3.25			0.25 (7)				0.07 (12)	0.32
3.25-3.75				0.14 (7)			0.07 (12)	0.21
3.75-4.75				0.08 (7)			0.03 (13)	0.11
4.75-5.75					0.05 (7)		0.03 (>13)	0.08
TOTAL	0.51	5.65	5.92	1.69	0.05		0.49	14.37

Table 3.1.1: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season

FLOOD SEASON

S	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25		1.59 (2)	0.30 (2)					1.89
0.25-0.75		4.94 (2.8)	1.70 (2)					6.58
0.75-1.25		2.60 (4)	5.16 (3.5)	0.17 (3)				7.93
1.25-1.75		0.40 (5)	4.82 (5)	0.47 (4)			0.31 (11)	5.98
1.75-2.25			2.91 (6)				0.10 (11)	3.01
2.25-2.75			1.07 (6)				0.16 (11)	1.23
2.75-3.25			0.48 (7)				0.15 (12)	0.63
3.25-3.75			0.27 (7)				0.15 (12)	0.42
3.75-4.75				0.16 (7)			0.05 (13)	0.21
4.75-5.75				0.09 (8)			0.05 (>13)	0.14
TOTAL		9.53	15.63	0.89			0.97	27.98

Table 3.1.m: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season

FLOOD SEASON

SW	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25		0.81 (2)						0.81
0.25-0.75		1.75 (2.8)	1.09 (2)					2.82
0.75-1.25		1.98 (4)	2.26 (3.5)	0.09 (3)				3.39
1.25-1.75		0.35 (5)	2.08 (5)				0.13 (11)	2.56
1.75-2.25			0.46 (6)	0.78 (5)			0.04 (11)	1.28
2.25-2.75			0.46 (6)				0.07 (11)	0.53
2.75-3.25			0.21 (7)				0.06 (12)	0.27
3.25-3.75			0.12 (7)				0.06 (12)	0.18
3.75-4.75				0.07 (8)			0.02 (13)	0.09
4.75-5.75				0.03 (9)			0.02 (>13)	0.05
TOTAL		3.89	6.68	0.97			0.33	11.98

Table 3.1.n: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season

FLOOD SEASON

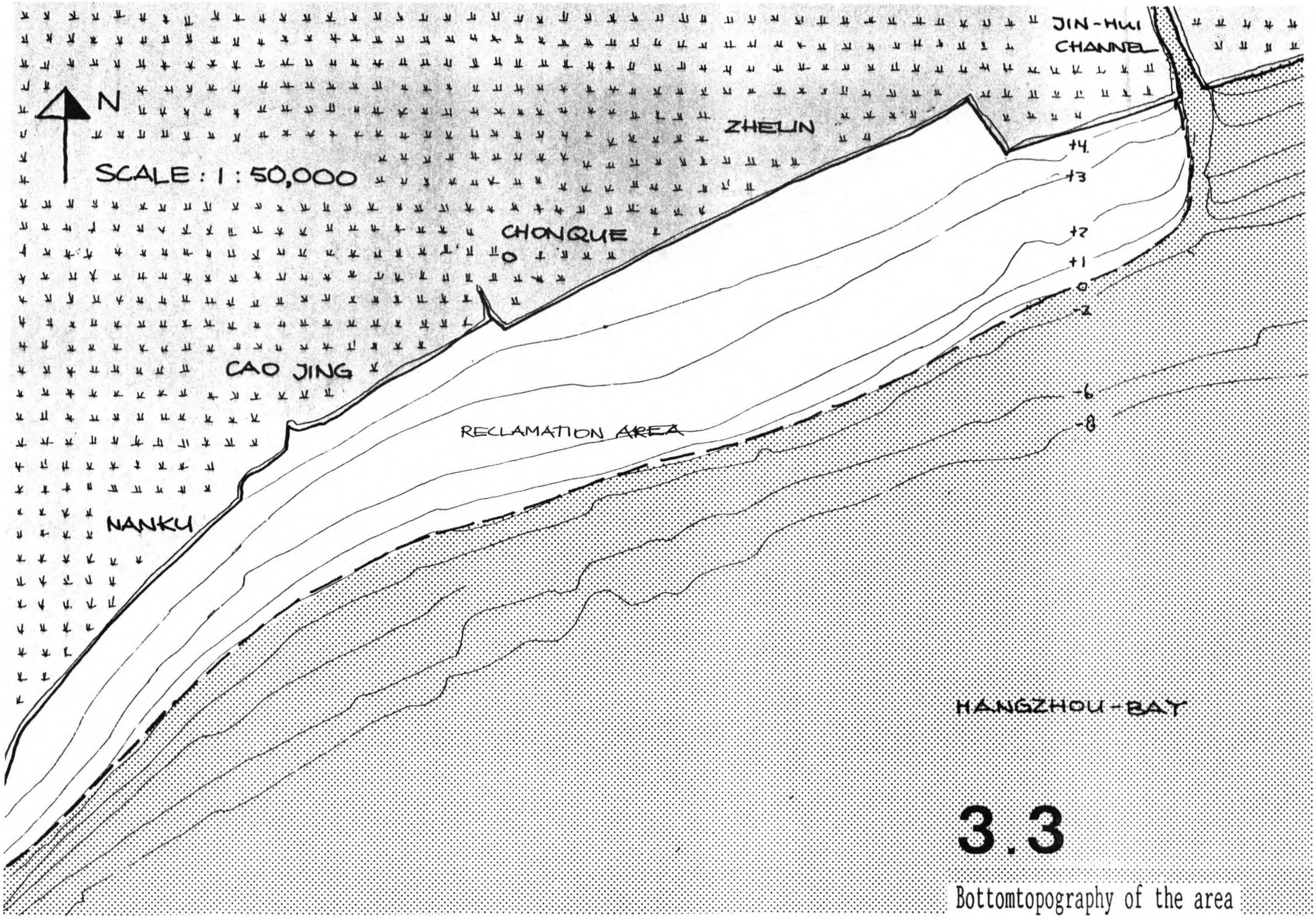
W	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.07 (2)	0.15 (2)						0.22
0.25-0.75		0.39 (2.8)	0.39 (2)					0.77
0.75-1.25		0.26 (4)	0.67 (3.5)					0.93
1.25-1.75			0.66 (5)					0.66
1.75-2.25			0.34 (6)					0.34
2.25-2.75				0.13 (6)				0.13
2.75-3.25					0.06 (6)			0.06
3.25-3.75								
3.75-4.75								
4.75-5.75								
TOTAL	0.07	0.80	2.06	0.13	0.06			3.28

Table 3.1.o: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season

FLOOD SEASON

N	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	SWELL	TOTAL
wave-height (m)				(wave-period(s))				
<0.25	0.31 (2)							0.31
0.25-0.75		0.55 (2.8)	0.45 (2)	0.05 (2)				1.07
0.75-1.25		0.27 (4)	0.74 (3.5)	0.27 (3)				1.29
1.25-1.75			0.33 (5)	0.55 (4)				0.92
1.75-2.25			0.14 (6)	0.33 (5)				0.47
2.25-2.75				0.18 (5.5)				0.18
2.75-3.25				0.02 (6)	0.08 (5)			0.08
3.25-3.75					0.04 (6)			0.04
3.75-4.75								
4.75-5.75								
TOTAL	0.31	0.82	1.66	1.40	0.12			4.56

Table 3.1.p: wave-height and wave-period versus wind-speed, in percentages of occurance during the flood season



3.3

Bottomtopography of the area

Refraction and shoaling

Now the wave-climate at Nan Hui Zui is known, the data have to be transfered to the Cao Jing district. At the coast of Cao Jing the waterdepth is much less than at Cape Nan Hui (0-5 m instead of 15-20 m), thus refraction and shoaling play an important part in recalculating the wave-data (see Fig. 3.3).

Dependent on the wind-direction (or wave-direction), the data of Nan Hui influence the data of Cao Jing. If we distinguish 8 different directions, following assumptions have been made:

- direction: N : the waves at the coastal zone of Cao Jing consist of short windwaves, generated in the short stretch between the coastline and the planned dike-trace.
  Data to be used : wind-data Nan Hui Zui.
  Fetch-length : maximum 3 km (dependent on tidal level).

- Direction: NE : again the waves are purely generated by the wind, considering a fetch-length equal to the distance between coastline and the planned dike-tracé.
  Data to be used : wind-data Nan Hui Zui.
  Fetch-length : maximum 3 km (dependent on tidal level).

- Direction: E : the waves from this direction originate from the direction of Cape Nan Hui. Since we consider the wind climate at Cao Jing the same as at Nan Hui, also the waves are considered the same, apart from refraction and shoaling.
  Data to be used : wave-data Nan Hui Zui.
  Fetch-length : ∞ km.
  Refraction and shoaling should be taken into account.

- Direction: SE : the same as for the East-direction; the same wave climate is assumed to be valid, apart from shoaling and refraction.
  Data to be used : wave-data Nan Hui Zui.
  Fetch-length : ∞ km.
  Refraction and shoaling should be taken into account.

- Direction: S : since the same wind-distribution is assumed valid for Nan Hui and Cao Jing, also the wave-distribution of Nan Hui is valid at Cao Jing, apart from shoaling and refraction and considering a limited fetch-length of 500 km.
  Data to be used : wave-data Nan Hui Zui.
  Fetch-length : 500 km.
  Refraction and shoaling should be taken into account.

- Direction: SW : the waves at Cao Jing originate from the same winds as the waves as Nan Hui, only the fetch-length is limited to 700 km.
  Data to be used : wave-data Nan Hui Zui.
  Fetch-length : 700 km.
  Refraction and shoaling should be taken into account.

- Direction: W : the wind blows offshore, creating waves in the stretch between the coastline and the planned dike-trace.
  Data to be used : wind-data Nan Hui Zui.
  Fetch-length : maximum 3 km (dependent on tidal level).

- Direction: NW : the waves are generated by the wind, growing over the length which is available between coastline and planned dike-trace.
  Data to be used : wind-data Nan Hui Zui.
  Fetch-length : maximum 3 km (dependent on tidal level).

Thus for the directions N, NE, NW and W the wind as given in table 3.1.a to 3.1.p generates waves, for the directions SW, S, SW and W the waves of Nan Hui Zui are refracted by the bottom-topography causing a change in the angle of approach of the waves and a change in the wave-height.

3.3.1 Wind-generated waves at shallow water with a short fetch-length

In case of the direction N, NE, W and NW the waves are caused by a certain windfield, acting over a certain fetch-length.

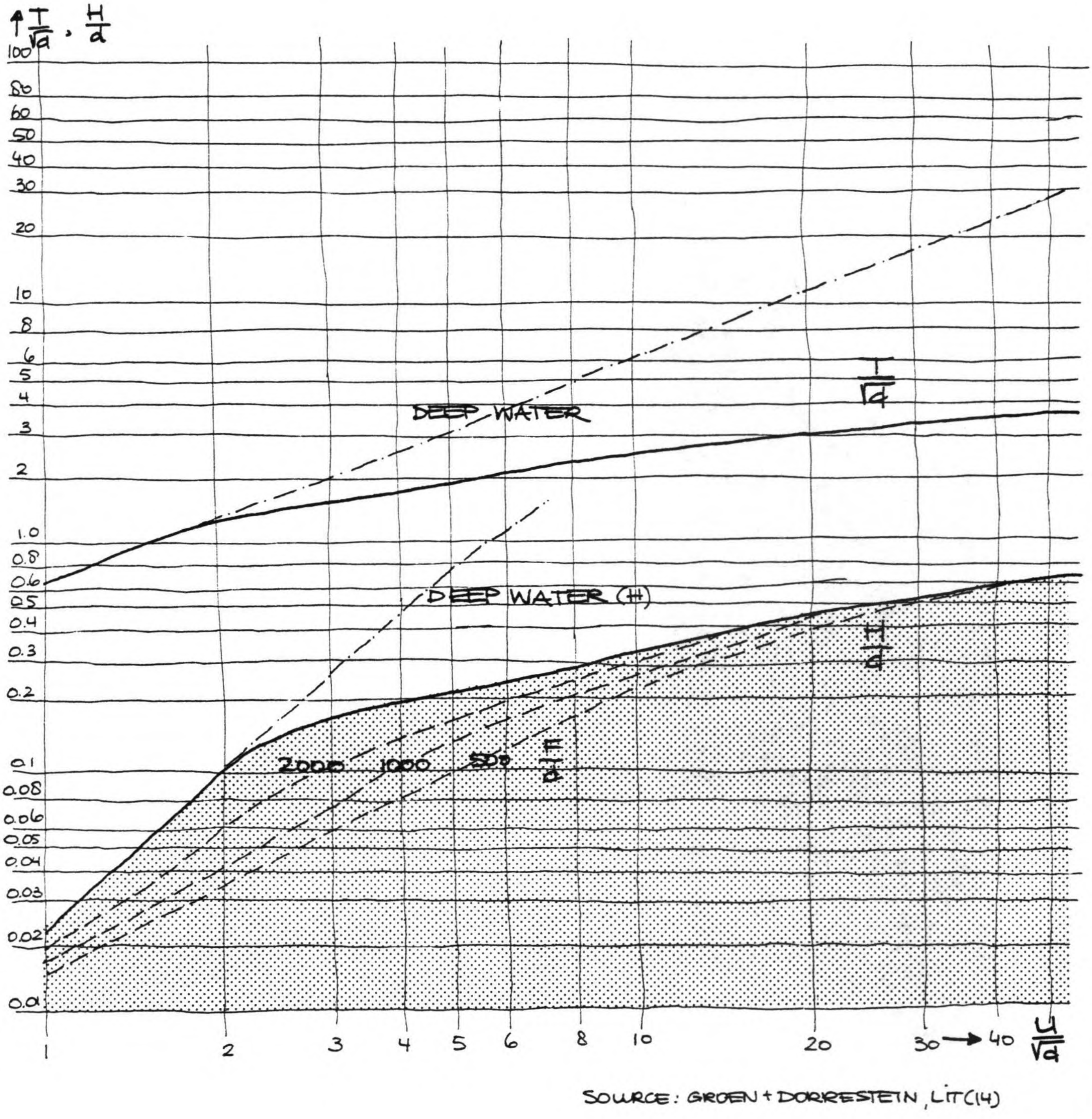
Also the waterdepth is important, since it limits the growth of the larger waves. Fig. 3.4 shows the relation between wave-height, wave-period and wind-speed (according to Groen and Dorrestein, lit. (14)) dependent on the waterdepth.

In par. 2.2 the tidal level showed to fluctuate between -1 and +6 m (Wusong level). Since the planned dike is to be built at a bottom level of +1 m the waterdepth will vary between 0 and 5 m (see table 2.4). In this analysis the fluctuating water-level is divided into 5 discrete intervals (see table 3.2):

waterdepth	1 (m)	2 (m)	3 (m)	4 (m)	5 (m)
- tidal interval	1.5-2.5 (m)	2.5-3.5 (m)	3.5-4.5 (m)	4.5-5.5 (m)	5.5-6.5 (m)
- duration					
non-flood	4.3	5.2	6.3	extreme	extreme
food	3.3	4.4	4.0	2.5	extreme
	(hours)	(hours)	(hours)	(hours)	*
- fetch-length	750 (m)	1,500 (m)	2,250 (m)	3,000 (m)	3,000 (m)

Table 3.2: applied intervals of waterdepth in case of offshore winds.

With the information given in table 3.1.a to 3.1.p and Fig. 3.4, the wave-climate at the Cao Jing district can be calculated.



3.4

Wind-generated waves at shallow water

EXAMPLE : if we want to know the distribution of the waves at Cao Jing, during flood-season, considering a waterdepth of 1 m and a wind-direction N (see table 3.1.i).

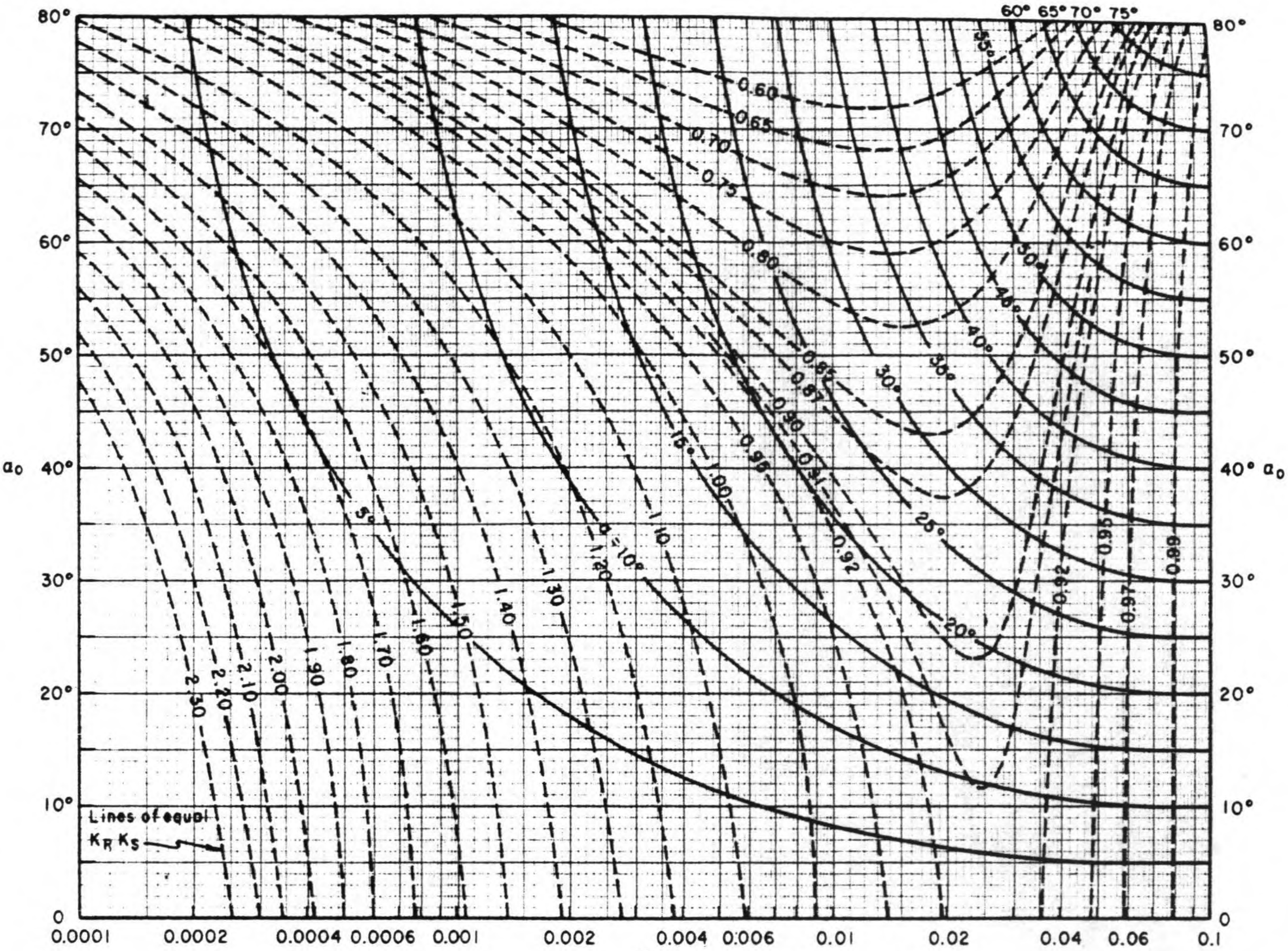
d = waterdepth = 1 m
F = fetch-length = 750 m
U = wind-speed = < 2 m/s : 0.92%
2 - 5 m/s : 2.53%
5 - 11 m/s : 7.43%
11 - 17 m/s : 2.28%
17 - 25 m/s : 0.14%
> 25 m/s : 0.00%
(percentages of occurrence during the season)

From Fig. 3.4 we learn that the significant wave-height never exceeds 0.5 m; only in case the wind-speed is over 15 m/s the significant wave-height exceeds 0.25 m (F/d = 750).

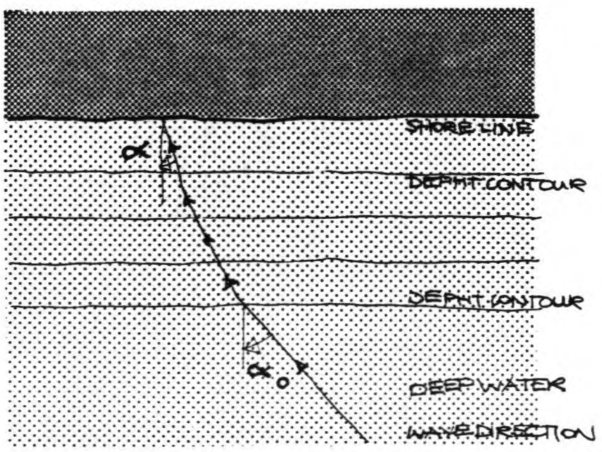
If we recalculate these data to fit the distribution at Cao Jing, we find:

wave direction = N
H = waveheight = < 0.25 m : 13.78%
0.25 m - 0.75 m : 0.14%
(percentages of occurrence during the season).

The same has been performed for each of the waterdepths and wind-directions given in table 3.1.a to 3.1.p. The results are given in table 3.4.a to 3.4.p.



SOURCE: SHORE PROTECTION MANUAL, LIT(6)



3.5

Refraction and shoaling

3.3.2 Refraction and shoaling of waves (large fetch-length)

In case of on-shore winds, the waves are in equilibrium with the windforces and the wave-growth has stopped (provided that the fetch-length is long enough). So, if the windfield at Cao Jing is the same as at Nan Hui, it is assumed that also the deep-water characteristics are the same.

Again the waterdepth is important, since the waves will be slowed down by the bottom-influence, dependent on the waterdepth. The same discrete intervals are used as given in table 3.2.
Also the wave-length is important to determine the refraction and shoaling coefficients. The wave-length is dependent of the wave-period, which is in the range of 2 s to 14 s at Nan Hui Zui (see par. 3.1).

Fig. 3.5 shows the wave-height coefficient and the angle of approach after refraction and shoaling (see: shore protection manual, lit (6)), in which:

d = waterdepth (m)
g = acceleration of gravity (m/s^2)
T = wave-period (s)
α_o = angle of approach at deep water (o°)
L_o = wave-length at deep water = $1.56\ T^2$ (s)
α = angle of approach after shoaling, refraction (o°)
KrKs = wave-height coefficient (-)

Applied on the suggested intervals it follows (see table 3.3)

T(s)			1 (m)		2 (m)		3 (m)		4 (m)		5 (m)	
2	d/gT^2		0.025		0.050		0.075		0.100		0.125	
	direction α_o		KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E	60°	0.77	45°	0.91	57°	0.98	59°	1.0	60°	1.0	60°
	SE	15°	0.91	13°	0.95	15°	0.99	15°	1.0	15°	1.0	15°
	S	-30°	0.89	-25°	0.97	-29°	0.99	-30°	1.0	-30°	1.0	-30°
	SW	-75°	0.61	-55°	0.75	-70°	0.95	-74°	1.0	-75°	1.0	-75°

Table 3.3: wave-height coefficients and angle of approach after refraction and shoaling

T(s)		1 (m)	2 (m)	3 (m)	4 (m)	5 (m)
3	$d/g\,T^2$	0.011	0.022	0.033	0.044	0.056
	direction α_o	KrKs α	KrKs α	KrKs α	KrKs α	KrKs α
	E 60°	0.75 32°	0.77 43°	0.82 50°	0.88 55°	0.93 58°
	SE 15°	0.96 9°	0.91 12°	0.92 13°	0.94 14°	0.97 15°
	S -30°	0.93 -18°	0.89 -23°	0.90 -26°	0.94 -28°	0.96 -29°
	SW -75°	0.60 -35°	0.60 -50°	0.73 -58°	0.82 -63°	0.85 -70°
4	$d/g\,T^2$	0.006	0.013	0.019	0.025	0.0313
	direction α_o	KrKs α	KrKs α	KrKs α	KrKs α	KrKs α
	E 60°	0.80 24°	0.74 35°	0.75 41°	0.77 46°	0.81 50°
	SE 15°	1.05 7.5°	0.94 10°	0.91 12°	0.91 13°	0.27 14°
	S -30°	1.02 -14°	0.91 -19°	0.88 -23°	0.88 -25°	0.90 -27°
	SW -75°	0.60 -32°	0.60 -41°	0.60 -47°	0.60 -56°	0.70 -62°

Table 3.3 (continued)

From hereon the depth at the measurements (about 15 m) starts to influence the coefficients as well. This means that the measured wave is subjected to a reduction coefficient already, due the the limited depth. The given coefficients in table 3.3 (continued) take into account a correction.

T(s)		1 (m)	2 (m)	3 (m)	4 (m)	5 (m)
5	$d/g\,T^2$	0.004	0.008	0.012	0.016	0.020
	direction α_o	KrKs α	KrKs α	KrKs α	KrKs α	KrKs α
	E 60°	0.87 18°	0.75 28°	0.75 33°	0.75 36°	0.75 42°
	SE 15°	1.15 6°	1.0 8°	0.95 10°	0.93 11°	0.91 12°
	S -30°	1.12 -11°	0.97 -15°	0.92 -18°	0.90 -20°	0.89 -23°
	SW -75°	0.62 -21°	0.60 -31°	0.60 -38°	0.55 -41°	0.60 -52°

Table 3.3 (continued)

T(s)		1 (m)		2 (m)		3 (m)		4 (m)		5 (m)	
6	d/g T^2	0.003		0.006		0.008		0.011		0.014	
	direction α_o	KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E 60°	0.90	16°	0.81	22°	0.77	28°	0.75	32°	0.74	35°
	SE 15°	1.30	5°	1.08	7°	1.00	8°	0.95	9°	0.93	10°
	S -30°	1.15	-10°	1.00	-14°	0.96	-15°	0.92	-18°	0.91	-20°
	SW -75°	0.65	-19°	0.60	-27°	0.58	-30°	0.55	-35°	0.55	-40°
7	d/g T^2	0.002		0.004		0.006		0.008		0.010	
	direction α_o	KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E 60°	0.97	14°	0.85	20°	0.80	24°	0.77	27°	0.75	30°
	SE 15°	1.35	4°	1.16	6°	1.08	7°	1.00	8°	0.97	9°
	S -30°	1.25	-8°	1.10	-11°	1.02	-14°	0.96	-15°	0.94	-17°
	SW -75°	0.70	-15°	0.62	-22°	0.60	-27°	0.57	-31°	0.55	-34°
8	d/g T^2	0.0016		0.0031		0.0047		0.0063		0.0078	
	direction α_o	KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E 60°	1.02	13°	0.90	17°	0.83	21°	0.80	24°	0.77	27°
	SE 15°	1.40	3°	1.20	5°	1.13	6°	1.03	8°	1.00	8°
	S -30°	1.33	-7°	1.17	-10°	1.07	-12°	1.00	-14°	0.97	-15°
	SW -75°	0.75	-14°	0.65	-19°	0.60	-25°	0.50	-29°	0.55	-32°
9	d/g T^2	0.0012		0.0024		0.0037		0.0049		0.0062	
	direction α_o	KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E 60°	1.10	10°	0.94	15°	0.87	18°	0.82	22°	0.80	25°
	SE 15°	1.50	3°	1.30	4°	1.18	6°	1.10	7°	1.07	7°
	S -30°	1.41	-7°	1.23	-8°	1.12	-11°	1.05	-13°	1.10	-14°
	SW -75°	0.80	-12°	0.68	-17°	0.63	-4°	0.60	-24°	0.60	-27°

Table 3.3 (continued)

T(s)			1 (m)		2 (m)		3 (m)		4 (m)		5 (m)	
10		d/gT^2	0.001		0.002		0.003		0.004		0.005	
	direction α_o		KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E	60°	1.12	10°	0.98	13°	0.90	17°	0.85	19°	0.82	22°
	SE	15°	1.58	3°	1.34	4°	1.20	5°	1.15	6°	1.10	7°
	S	-30°	1.50	-6°	1.27	-8°	1.15	-10°	1.10	-11°	1.05	-13°
	SW	-75°	0.83	-11°	0.70	-15°	0.65	-19°	0.61	-22°	0.60	-25°
11		d/gT^2	0.0008		0.0017		0.0025		0.0033		0.0041	
	direction α_o		KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E	60°	1.20	9°	1.02	12°	0.92	15°	0.88	18°	0.84	20°
	SE	15°	1.66	3°	1.39	4°	1.28	5°	1.18	5°	1.15	6°
	S	-30°	1.57	-5°	1.32	-8°	1.20	-9°	1.14	-10°	1.07	-11°
	SW	-75°	0.85	-10°	0.72	-14°	0.67	-17°	0.65	-20°	0.61	-23°
12		d/gT^2	0.0007		0.0014		0.0021		0.0028		0.0035	
	direction α_o		KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E	60°	1.24	8°	1.06	12°	0.96	14°	0.90	16°	0.87	18°
	SE	15°	1.78	2°	1.43	3°	1.33	4°	1.24	5°	1.18	6°
	S	-30°	1.60	-5°	1.39	-7°	1.25	-8°	1.18	-9°	1.02	-11°
	SW	-75°	0.90	-9°	0.75	-13°	0.70	-15°	0.66	-18°	0.62	-21°
13		d/gT^2	0.0006		0.0012		0.0018		0.0024		0.003	
	direction α_o		KrKs	α	KrKs	α	KrKs	α	KrKs	α	KrKs	α
	E	60°	1.29	8°	1.10	10°	1.0	13°	0.92	15°	0.90	17°
	SE	15°	1.78	2°	1.50	3°	1.42	4°	1.30	5°	1.22	5°
	S	-30°	1.68	-4°	1.46	-6°	1.32	-8°	1.22	-9°	1.17	-10°
	SW	-75°	0.90	-9°	0.78	-12°	0.75	-15°	0.60	-17°	0.65	-19°

Table 3.3 (continued): wave-height coefficients and angle of approach after refraction and shoaling

Using table 3.3 the wave-data of Nan Hui Zui can be transformed to the Cao Jing district.

EXAMPLE : if we want to know the distribution of the waves at Cao Jing, during flood-season considering a waterdepth of 1 m and a (wind-)direction S (see table 3.1.m).

d = waterdepth = 1 m
F = fetch-length = 500 km.

From Fig. 3.2 it can be found that such a fetch-length does not (except in extreme situations) limit the growth of the waves; refraction and shoaling do.

This example is now focussed on the calculation of one specific wave-class (see table 3.1.m).

NAN HUI : H = wave-height = 1.25-1.75 m : 4.82%
α_o = -30° (S-direction).

According to table 3.3, considering T = 5 s.

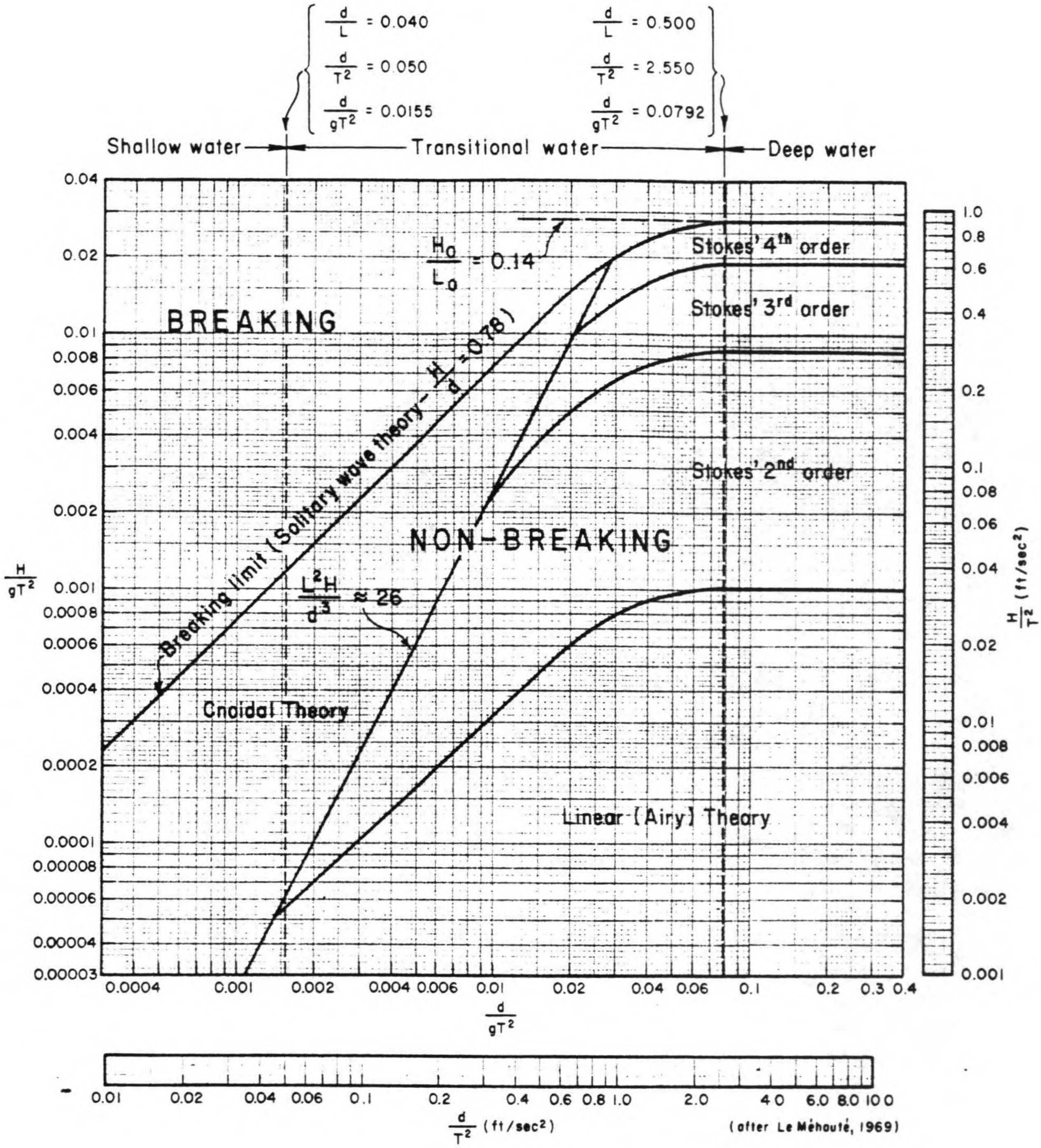
KrKs = 1.12 = wave-height coefficient at d = 1 m.
α = -11° = new angle of approach at d = 1 m.

CAO JING: H = wave-height = 1.40-1.96 m : 4.82%
α = -11° (S-SE-direction).

Since the distribution at Cao Jing should be expressed in the same wave-height intervals and direction-intervals as at Nan Hui, this information must be re-arranged, using lineair interpolation.

CAO JING: H = wave-height = 1.25-1.75 m : 1.82%
= 1.75-2.25 m : 1.14%
α = -30° (S-direction)
plus:
H = wave-height = 1.25-1.75 m : 1.08%
= 1.75-2.25 m : 0.78%
α = 15° (SE-direction)
4.82%

For each wave-class this calculation can be made, the results are given in table 3.4.a to 3.4.p (percentages of occurence during the season).



3.6

Breaking wave-height

3.4 Distribution of waves at the Cao Jing district

Except for the wind-generation of waves at shallow water in case of short fetch-lengths and refraction plus shoaling of waves at shallow water in case of long fetch-lengths, also another phenomenon is important at Cao Jing:
the breaking criterion.

Since the slope of the bottom is very flat (1:150, see Fig. 3.3) the maximum wave-height will eventually be limited by the breaking-criteria, when the wave approaches the coast of Cao Jing. In Fig. 3.6, originating from lit. (6), the breaking criteria is given. The ultimate breaking-rule, referring to the waterdepth is:

$$H_{max} = 0.78\ d \quad \text{.......................................(6)}$$

Thus, dependent on the waterdepth, following maximum wave-heights are possible:

d = 1 m H_{max} = 0.78 m
d = 2 m H_{max} = 1.56 m
d = 3 m H_{max} = 2.34 m
d = 4 m H_{max} = 3.13 m
d = 5 m H_{max} = 3.90 m

So in the upper part of the wave-distribution the very extreme waves are projected to the class in which the waves break (see tables 3.4.a to .p).

The refraction and shoaling-calculations and the wind-generated waves have been summarized, resulting in the tables 3.4.a to .p.

The distribution of the wave-periods remains the same as for Nan Hui, for the directions S, SE, E and SW.
In case of off-shore winds most of the time the wave-period will be in the order of 2 s (see Fig. 3.4).

NON-FLOOD SEASON

N d (m) / F (m)	1 750	2 1,500	3 2,250	4 3,000	5 3,000	Nan Hui ∞
wave-height (m)						
<0.25	35.85	30.89	22.89	18.67	13.09	3.39
0.25-0.75	0.87	5.82	13.82	18.04	22.75	6.45
0.75-1.25					0.87	10.99
1.25-1.75						6.84
1.75-2.25						4.98
2.25-2.75						2.13
2.75-3.25						1.03
3.25-3.75						0.35
3.75-4.75						0.35
TOTAL	36.71	36.71	36.71	36.71	36.71	36.71

Table 3.4.a: wave-height against waterdepth in percentages of occurrence during the non-flood season

NE d (m) / F (m)	1 750	2 1,500	3 2,250	4 3,000	5 3,000	Nan Hui ∞
wave-height (m)						
<0.25	21.90	18.39	13.39	10.85	7.49	2.05
0.25-0.75		3.51	8.51	11.05	14.41	3.89
0.75-1.25						6.63
1.25-1.75						3.86
1.75-2.25						3.01
2.25-2.75						1.32
2.75-3.25						0.48
3.25-3.75						0.21
3.75-4.75						0.21
TOTAL	21.90	21.90	21.90	21.90	21.90	21.90

Table 3.4.a: wave-height versus waterdepth in percentages of occurrence during the non-flood season

NON-FLOOD SEASON

E d (m) / F (m)	1 ∞	2 ∞	3 ∞	4 ∞	5 ∞	Nan Hui
wave-height (m)						
<0.25	0.79	1.05	1.06	1.04	1.01	0.97
0.25-0.75	1.92	1.96	2.30	2.44	2.43	1.84
0.75-1.25		1.33	1.91	2.33	2.94	3.33
1.25-1.75		1.03	0.61	0.81	1.06	1.93
1.75-2.25			0.19	0.23	0.27	1.39
2.25-2.75			0.08	0.06	0.08	0.52
2.75-3.25				-	-	0.46
3.25-3.75						
3.75-4.75						
TOTAL	2.71	5.73	6.15	6.91	7.79	10.21

Table 3.4.c: wave-height versus waterdepth in percentages of occurrence during the non-flood season

SE d (m) / F (m)	1	2	3	4	5	Nan Hui
wave-height (m)						
<0.25	1.07	0.69	0.60	0.56	0.54	0.53
0.25-0.75	12.48	2.37	1.96	1.67	1.32	1.00
0.75-1.25		3.39	3.04	2.77	2.54	1.71
1.25-1.75		4.26	2.07	2.00	1.72	1.06
1.75-2.25			1.13	1.08	1.13	0.76
2.25-2.75			0.96	0.37	0.47	0.29
2.75-3.25				0.13	0.05	0.12
3.25-3.75					0.05	
3.75-4.75						
TOTAL	13.55	10.76	9.76	8.79	7.85	5.43

Table 3.4.d: wave-height versus waterdepth in percentages of occurrence during the non-flood season

NON-FLOOD SEASON

S d (m) F (m)	1 5.10^5	2 5.10^5	3 5.10^5	4 5.10^5	5 5.10^5	Nan Hui ∞
wave-height (m)						
<0.25	0.66	0.57	0.49	0.46	0.45	0.44
0.25-0.75	5.07	1.67	1.51	1.39	1.12	0.83
0.75-1.25		1.72	1.84	1.89	1.90	1.42
1.25-1.75		1.81	0.97	0.86	0.79	0.87
1.75-2.25			0.43	0.59	0.55	0.64
2.25-2.75			0.28	0.22	0.23	0.24
2.75-3.25				0.03	0.01	
3.25-3.75					0.01	
3.75-4.75						
TOTAL	5.76	5.77	5.52	5.44	5.06	4.44

Table 3.4.e: wave-height versus waterdepth in percentages of occurrence during the non-flood season

SW d (m) F (m)	1 7.10^5	2 7.10^5	3 7.10^5	4 7.10^5	5 7.10^5	Nan Hui ∞
wave-height (m)						
<0.25	0.18	0.28	0.28	0.28	0.28	0.25
0.25-0.75	0.14	0.42	0.62	0.78	0.73	0.48
0.75-1.25		0.01	0.15	0.25	0.66	0.81
1.25-1.75		-	-	0.03	0.07	0.50
1.75-2.25			-	-	-	0.35
2.25-2.75			-	-	-	0.14
2.75-3.25				-	-	
3.25-3.75					-	
3.75-4.75						
TOTAL	0.32	0.71	1.05	1.34	1.74	2.53

Table 3.4.f: wave-height versus waterdepth in percentages of occurrence during the non-flood season

NON-FLOOD SEASON

W d (m) F (m)	1 750	2 1,500	3 2,250	4 3,000	5 3,000	Nan Hui ∞
wave-height (m)						
<0.25	2.14	2.14	1.64	1.39	1.14	0.20
0.25-0.75			0.50	0.75	1.00	0.39
0.75-1.25						0.65
1.25-1.75						0.40
1.75-2.25						0.29
2.25-2.75						0.13
2.75-3.25						
3.25-3.75						
3.75-4.75						
TOTAL	2.14	2.14	2.14	2.14	2.16	2.14

Table 3.4.g: wave-height versus waterdepth in percentages of occurrence during the non-flood season

NW d (m) F (m)	1 750	2 1,500	3 2,250	4 3,000	5 3,000	Nan Hui ∞
wave-height (m)						
<0.25	14.42	11.97	7.97	5.98	4.00	1.33
0.25-0.75	0.21	2.66	6.66	8.55	10.42	2.53
0.75-1.25				0.10	0.21	4.32
1.25-1.75						2.66
1.75-2.25						1.91
2.25-2.75						0.03
2.75-3.25						0.31
3.25-3.75						0.14
3.75-4.75						0.14
TOTAL	14.63	14.63	14.63	14.63	14.63	14.63

Table 3.4.h: wave-height versus waterdepth in percentages of occurrence during the non-flood season

FLOOD SEASON

N d (m) / F (m)	1 / 750	2 / 1,500	3 / 2,250	4 / 3,000	5 / 3,000	Nan Hui / ∞
wave-height (m)						
<0.25	13.66	11.38	7.54	4.38	3.93	0.94
0.25-0.75	0.26	2.54	6.26	9.35	9.71	3.27
0.75-1.25			0.12	0.19	0.26	3.94
1.25-1.75						2.98
1.75-2.25						1.50
2.25-2.75						0.61
2.75-3.25						0.31
3.25-3.75						0.21
3.75-4.75						0.08
TOTAL	13.92	13.92	13.92	13.92	13.92	13.92

Table 3.4.i: wave-height versus waterdepth in percentages of occurrence during the flood season

NE d (m) / F (m)	1 / 750	2 / 1,500	3 / 2,250	4 / 3,000	5 / 3,000	Nan Hui / ∞
wave-height (m)						
<0.25	10.19	8.78	6.48	4.87	4.07	0.69
0.25-0.75	0.09	1.50	3.80	5.41	6.12	2.42
0.75-1.25					0.09	2.91
1.25-1.75						2.20
1.75-2.25						1.10
2.25-2.75						0.45
2.75-3.25						0.23
3.25-3.75						0.15
3.75-4.75						0.08
TOTAL	10.28	10.28	10.28	10.28	10.28	10.28

Table 3.4.j: wave-height versus waterdepth in percentages of occurrence during the flood season

FLOOD SEASON

E d (m) / F (m)	1 ∞	2 ∞	3 ∞	4 ∞	5 ∞	Nan Hui ∞
wave-height (m)						
<0.25	0.66	0.91	0.89	0.84	0.81	0.73
0.25-0.75	1.74	2.33	2.75	3.05	3.25	2.56
0.75-1.25		1.20	1.74	2.29	2.79	3.08
1.25-1.75		0.44	0.33	0.54	0.78	2.32
1.75-2.25			0.23	0.23	0.26	1.17
2.25-2.75			0.07	0.05	0.08	0.48
2.75-3.25				0.05	0.04	0.25
3.25-3.75					0.01	0.17
3.75-4.75					0.02	0.08
TOTAL	2.40	4.20	6.02	7.05	8.04	10.88

Table 3.4.k: wave-height versus waterdepth in percentages of occurrence during the flood season

SE d (m) / F (m)	1 ∞	2 ∞	3 ∞	4 ∞	5 ∞	Nan Hui ∞
wave-height (m)						
<0.25	1.73	2.55	1.16	1.08	1.03	0.97
0.25-0.75	28.99	6.00	5.06	3.91	4.07	3.38
0.75-1.25		6.51	5.98	5.98	5.63	4.07
1.25-1.75		11.73	4.64	4.47	4.18	3.07
1.75-2.25			2.85	2.51	2.35	1.54
2.25-2.75			2.98	0.90	0.82	0.63
2.75-3.25				1.52	0.65	0.32
3.25-3.75					0.41	0.21
3.75-4.75					0.48	0.19
TOTAL	30.72	26.07	22.70	20.92	19.63	14.37

Table 3.4.1: wave-height versus waterdepth in percentages of occurrence during the flood season

FLOOD SEASON

S d (m) F (m)	1 5.10^5	2 5.10^5	3 5.10^5	4 5.10^5	5 5.10^5	Nan Hui ∞
wave-height (m)						
<0.25	2.96	2.43	2.26	2.06	2.00	1.89
0.25-0.75	27.49	9.92	9.30	9.02	7.93	6.58
0.75-1.25		8.64	9.95	9.99	9.95	7.93
1.25-1.75		10.00	4.91	4.63	5.01	5.98
1.75-2.25			2.28	2.68	2.71	3.01
2.25-2.75			2.47	1.03	0.90	1.23
2.75-3.25				1.23	0.48	0.63
3.25-3.75					0.36	0.42
3.75-4.75					0.35	0.21
TOTAL	30.45	31.00	31.20	30.64	29.69	27.98

Table 3.4.m: wave-height versus waterdepth in percentages of occurrence during the flood season

SW d (m) F (m)	1 7.10^5	2 7.10^5	3 7.10^5	4 7.10^5	5 7.10^5	Nan Hui ∞
wave-height (m)						
<0.25	0.77	1.17	0.98	0.94	0.91	0.01
0.25-0.75	0.88	2.53	3.30	3.90	3.81	2.82
0.75-1.25		0.07	0.85	1.32	2.81	3.39
1.25-1.75		0.01	0.07	0.09	0.31	2.56
1.75-2.25					0.02	1.28
2.25-2.75						0.53
2.75-3.25						0.27
3.25-3.75						0.18
3.75-4.75						0.09
TOTAL	1.65	3.78	5.21	6.24	7.86	11.98

Table 3.4.n: wave-height versus waterdepth in percentages of occurrence during the flood season

FLOOD SEASON

W — d (m) / F (m)	1 / 750	2 / 1,500	3 / 2,250	4 / 3,000	5 / 3,000	Nan Hui / ∞
wave-height (m)						
<0.25	3.22	3.09	2.06	1.54	1.03	0.22
0.25-0.75	0.06	0.19	1.22	1.74	2.69	0.77
0.75-1.25					0.06	0.93
1.25-1.75						0.66
1.75-2.25						0.34
2.25-2.75						0.13
2.75-3.25						0.06
3.25-3.75						
3.75-4.75						
TOTAL	3.28	3.28	3.28	3.28	3.28	3.28

Table 3.4.o: wave-height versus waterdepth in percentages of occurrence during the flood season

NW — d (m) / F (m)	1 / 750	2 / 1,500	3 / 2,250	4 / 3,000	5 / 3,000	Nan Hui / ∞
wave-height (m)						
<0.25	4.44	3.02	2.24	1.84	1.38	0.31
0.25-0.75	0.12	1.52	2.32	2.66	3.06	1.07
0.75-1.25				0.06	0.12	1.29
1.25-1.75						0.92
1.75-2.25						0.47
2.25-2.75						0.18
2.75-3.25						0.08
3.25-3.75						0.04
3.75-4.75						
TOTAL	4.56	4.56	4.56	4.56	4.56	4.56

Table 3.4.p: wave-height versus waterdepth in percentages of occurrence during the flood season

NON-FLOOD d (m)	1	2	3	4	5	Nan Hui
wave-height (m)						
<0.25	77.1	65.98	48.32	39.23	28.00	9.16
0.25-0.75	20.69	18.41	35.88	44.47	54.18	17.02
0.75-1.25		6.45	6.94	7.34	9.12	29.66
1.25-1.75		7.10	3.65	3.70	3.64	18.12
1.75-2.25			1.75	1.90	1.95	13.33
2.25-2.75			1.34	0.65	0.78	5.60
2,75-3,25				0.14	0.06	2.40
3.25-3.75					0.06	0.70
3.75-4.75						0.70
AVERAGE	0.20	0.35	0.43	0.46	0.51	1.20

Table 3.5.a: distribution of wave-heights during non-flood season, percentages of occurrence

FLOOD d (m)	1	2	3	4	5	Nan Hui
wave-height (m)						
<0.25	37.63	33.03	23.61	17.55	15.16	6.66
0.25-0.75	59.63	26.53	34.21	39.04	40.14	22.87
0.75-1.25		16.42	18.64	19.83	21.71	27.54
1.25-1.75		22.18	9.95	9.73	10.28	20.69
1.75-2.25			5.56	5.42	5.34	10.41
2.25-2.75			5.52	1.98	1.80	4.24
2.75-3.25				2.80	1.17	2.15
3.25-3.75					0.78	1.38
3.75-4.75					0.85	0.73
AVERAGE	0.35	0.67	0.78	0.80	0.84	1.15

Table 3.5.b: distribution of wave-heights during flood season, percentages of occurrence

From tables 3.5 a, b the distribution of waves during the season can be found (see Fig. 3.7).
From the foregoing, it shows that the longer waves (especially swell) cause the larger wave-heights at the Cao Jing district. It is also obvious, that during the flood season, when the main wind-direction is south, the wave-action is much stronger than during the non-flood season.

The long-term wave distribution is expected to follow an exponential distribution:

$$p\ (H > \underline{H}) = \exp \frac{-\ H - a}{b} \qquad \ldots\ldots (7)$$

The percentages of occurrence found from tables 3.4 a to p and 3.5 a, b, coincide with this assumption. Fig. 3.7 shows a graphical interpretation of the calculated wave-climate.

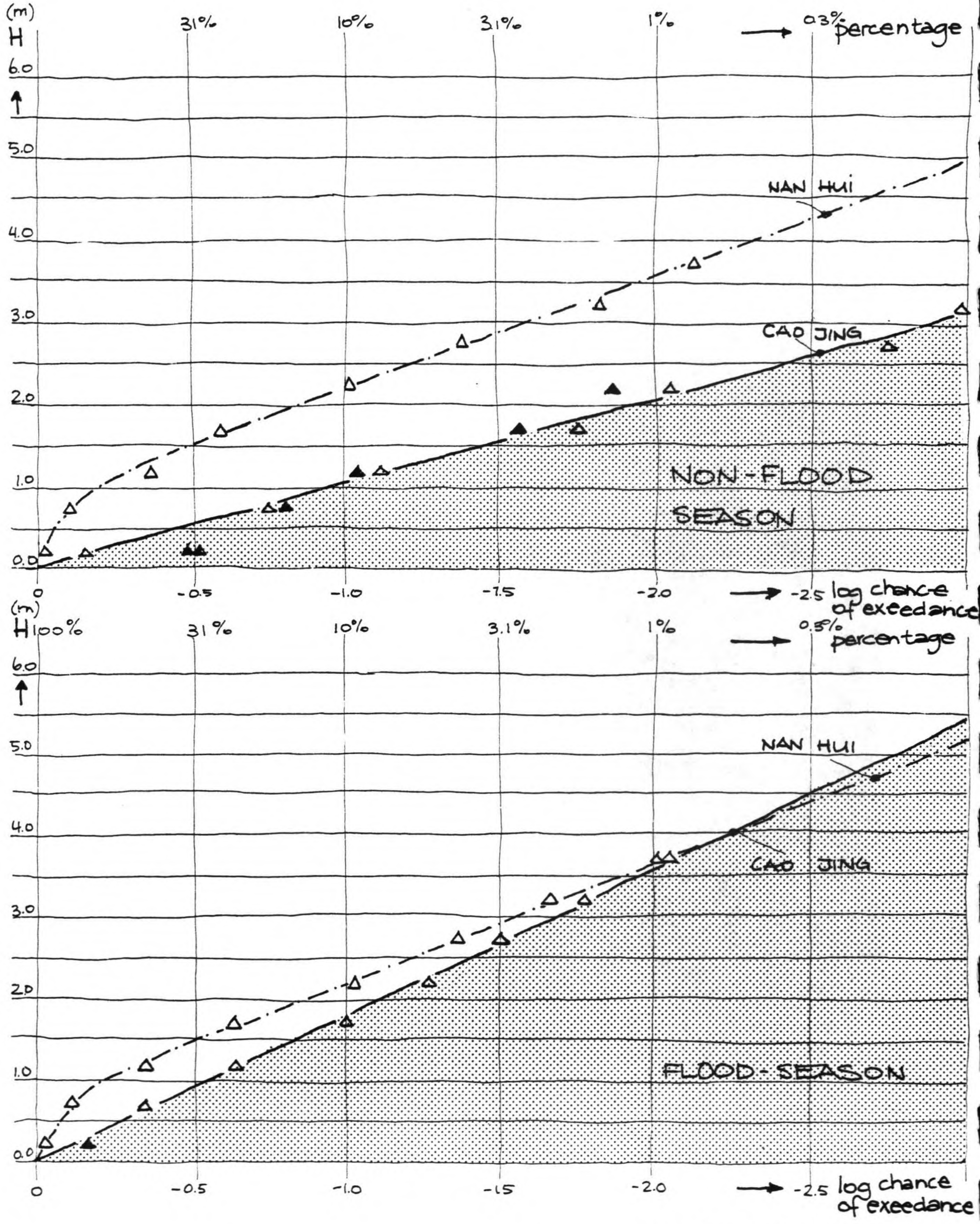
In the extreme regions the wave-height is limited by the breaking-criterion:

$$H_{max} = 0.78\ d \qquad \ldots\ldots (6)$$

Then the water-level distribution (see Fig. 2.2 and 2.3) determines the wave-height distribution.
The physical interpretation of this phenomenon is as follows: the extreme wave-height occurs during an extreme storm (typhoon-conditions), which causes an extreme water-level. The significant wave-height which coincides with this water-level is dependent on the water-level:

$$H_s = 0.5\ d \qquad \ldots\ldots (8)$$

During the storm the wave-heights follow a Rayleigh-distribution, which is determined by the significant wave-height (not by the long-term wave distribution), thus the waterdepth.



3.7

Distribution of wave-heights at Cao Jing

Thus, at a bottom-level of +1,00 m (Wusong-level) (see Fig. 3.8) the long-term water-levels follow an exponential distribution

$$p\ (h \geq \underline{h}) = e^{-4.1\ (\underline{h}\ -\ 3.75)} \qquad (4)$$

The long-term significant wave-heights under extreme conditions also follow an exponental distribution (d = h - 1):

$$p\ (H_s \geq \underline{H_s}) = e^{-8.2\ (\underline{H}s\ -\ 1.40)} \qquad (9)$$

and the long-term maximum wave-heights under extreme conditions also follow an exponential distribution:

$$p\ (H_{max} \geq \underline{H_{max}}) = e^{-5.3\ (\underline{Hmax}\ -2.15)} \qquad (10)$$

The distribution of "normal" wave-heights is given in Fig. 3.7.

The chance that the maximum wave occurs once during the storm is:

$$P_{once} = 1 - [1 - p\ (H \geq H_{max})]^N = 0.99$$

Thus the maximum wave-height is occuring almost certainly during the storm.

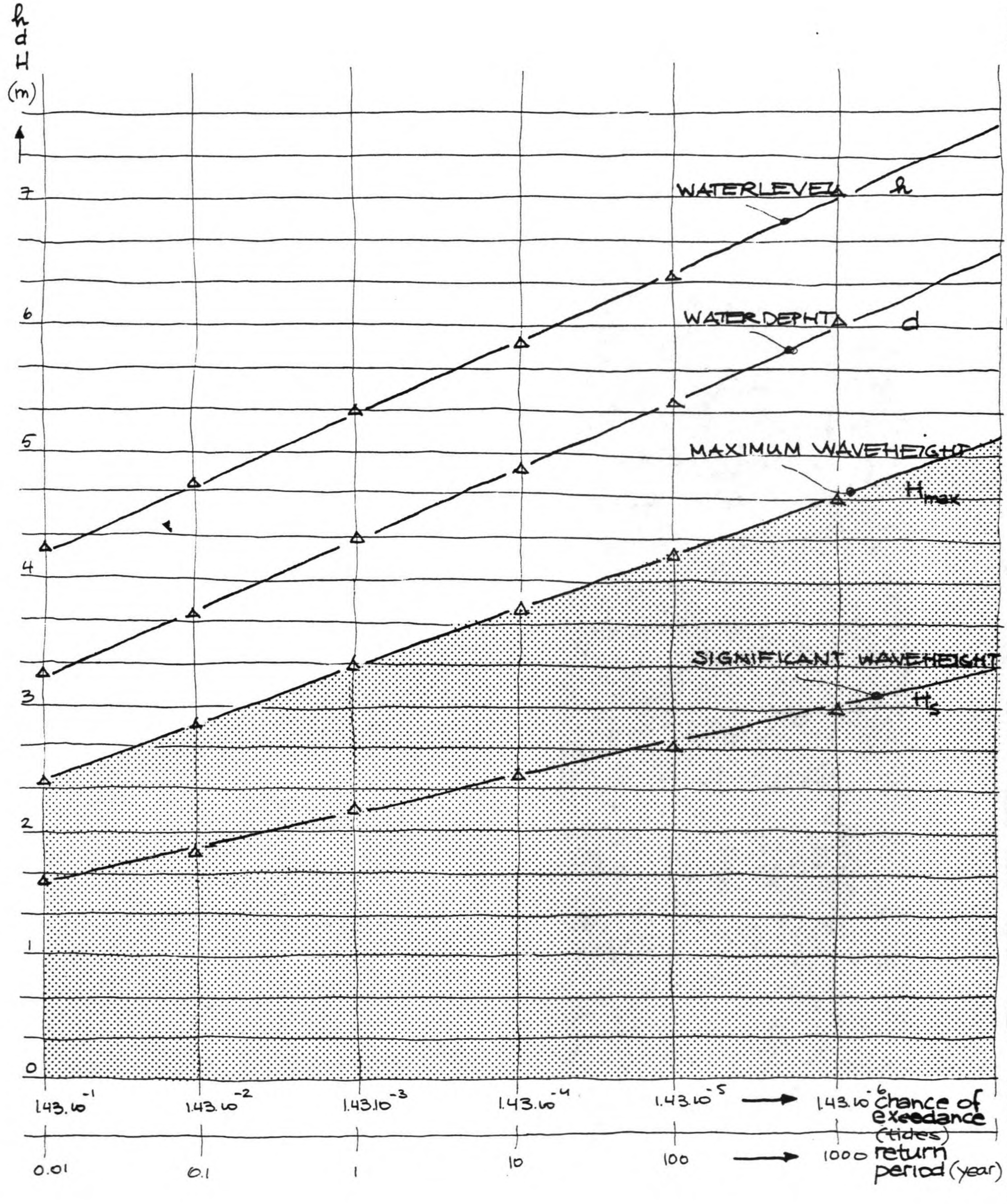
N.B. The chance that the maximum wave-height occurs, during a storm with a certain significant wave-height, can be found by assuming a Rayleigh-distribution of the waves during the storm:

$$p\ (H \geq \underline{H}) = e^{-2\ (\underline{H}/HS)2} \qquad (11)$$

Since H_s = 0.5 d, and H_{max} = 0.78d, during the storm:

$$p\ (H \geq H_{max}) = 0.0077$$

During this storm the high level stays about one hour, considering a wave-period of 6 sec. (eq. (5)) a number of 600 waves occurs during the storm (N = 600).



3.8

Return-period of extreme wave-heights at Cao Jing

CONCLUSION

The distribution of the wave-heights at the Cao Jing district can be found by transforming a measured wave-spectrum at Nan Hui to the Cao Jing district, taking into account the wind-direction and refraction plus shoaling.

The results of this calculation are shown in tables 3.4.a to p and in Fig. 3.7.

The distribution of the extreme wave-heights is directly dependent on the water-level and can be found by the breaking-criterion: $H = 0.78\ d$.

The results of this calculation are shown in Fig. 3.8.

There exists a considerable difference between the wave-action during flood season and non-flood season. This is mainly due to the prevailing wind-direction. For the wave-action during the year following is valid:

water-level (m)	waterdepth (m)	NON-FLOOD season average wave-height	duration	FLOOD season average wave-height	duration
<1.5	0	0.00 m	8.2 hours	0.00 m	9.8 hours
1.5-2.5	1	0.20 m	4.3 hours	0.35 m	3.3 hours
2.5-3.5	2	0.35 m	5.2 hours	0.67 m	4.4 hours
3.5-4.5	3	0.43 m	6.3 hours	0.78 m	4.0 hours
4.5-5.5	4	*	extreme	0.80 m	2.5 hours
5.5-6.5	5	*	extreme	*	extreme

Table 3.6: average wave-climate and duration at Cao Jing

4. RELATIONS BETWEEN WAVE-CLIMATE AND LAY-OUT

4.1 Admissable wave-action inside the fields

The object of the reclamation-fields is to create a calm area, in which the sediments, carried by the tidal motion, can settle. In the foregoing study, lay-out part I (lit. (12)), it has been found that the total number of incoming sediments is mainly determined by the storage-mechanism (eddy-development increases the number of incoming sediments, dependent on the size of the opening at the seaward end).
The concentration of sediments which leave the reclamation fields when the tide is descending, is dependent on the wave-action and current-velocity inside the fields.

The best results will be achieved if the outgoing sediment concentration is zero and thus the wave-action and current velocity are also zero. This however would require uneconomic dimensions of the reclamation fields and an uneconomical height of the dikes.

The sediment-concentration, or more specific the entrainment of sediments, is dependent on the shear-stress at the bottom. This shear-stress is caused by the water-velocity and by the waves. Bijker (lit. (13)) gives for the combined shear-stress:

$$\tau = \tau_c + \tfrac{1}{2}\,\hat{\tau}_w \qquad (11)$$

in which:

τ = combined shear-stress (N/m2)
τ_c = shear-stress caused by currents (N/m2)
= $\rho\,(u_*)\,u_*$
U_* = shear-stress velocity at the bottom = $\sqrt{g}\,\bar{u}/C$ (m/s)
$\bar{U}$ = depth-averaged velocity (m/s)
g = acceleration of gravity (m/s2)
C = Chézy roughness value ($\sqrt{m}$/s)
= 18 log (12 h/r)
$\hat{\tau}_w$ = maximum shear-stress caused by waves (N/m2)
= $\tfrac{1}{2}\,f_w \rho \hat{u}_b^{\,2}$
ρ = density of water (kg/m3)

f_w = friction parameter with respect to waves (-)
= exp. $[-5.977 + 5.213 (a_b/r)^{-0.194}]$
u_b = maximum orbital velocity at the bottom (m/s)
= $\omega H/2 \sinh kh$
a_b = maximum displacement of the wave (m)
= $\omega \hat{u}_b$
ω = wave-frequency = $2\pi/T$ (rad/s)
T = wave-period (s)
r = roughness of the bottom (m)
h = waterdepth (m)
H = wave-height (m)
k = wave number = $2\pi/L$ (rad/m)
L = wave-length (m)

According to Shields there exists a critical shear-stress. When this critical shear-stress is exceeded the particles of the bottom will go into suspension. For materials at the Cao Jing district (D_{50} = 50 µm) this critical shear-stress is (see the report LAY-OUT part I):

τ_{cr} = 0.156 N/m2

($u_{*,cr} = 1.25.10^{-2}$ m/s)

However this criterion would result in an admissable wave-height (not taking into account any currents) of H = 0.04 m, which is an unrealistic low value. Since the object of the reclamation-basins is to reduce the transport of sediments in this analysis it is assumed a certain admissable transport, which will result in an admissable shear-stress and an admissable wave-height. The transport-rate of the sediments can be found by the formula of Van Rijn (see report LAY-OUT part I, lit (12)):

$$S = F\bar{u}hc_a + S_b \qquad (12)$$

in which:

S = transport of sediments (m2/s)
S_b = bed-load transport (m2/s)
= $0.053\ T^{2.1}\ D_*^{-0.3}\ D_{50}^{1.8}\ \Delta\sqrt{g}$
T = transport-stage parameter (-)
= $(\tau' - \tau_{cr})/\tau_{cr}$
τ' = shear-stress at bottom with respect to grains (N/m2)
= $\tau'_c + \frac{1}{2}\hat{\tau}_w$

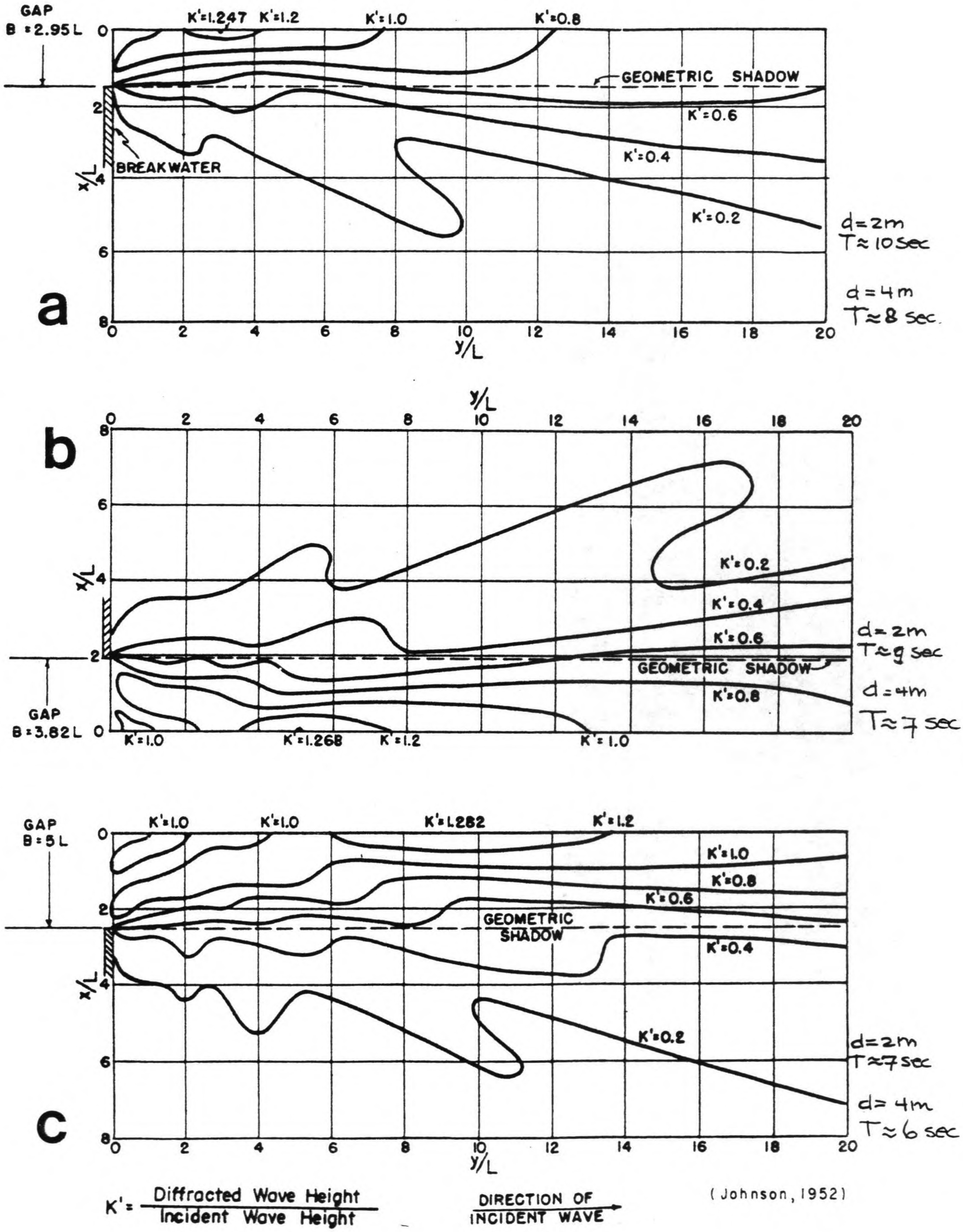
τ'_c = shear-stress at bottom due to currents (relative to grain)
= $\rho\ (\bar{u}\ \sqrt{g}/C')^2$
C' = Chézy-value related to grains ($\sqrt{m}/s$)
= 18 log (12 h/3 D_{90})
D_* = particle diameter parameter (-) = 1.27
= $D_{50}\ [\Delta g/\upsilon^2]^{1/3}$
Δ = density-parameter = 1.65 (-)
ν = kinematic viscosity = 1.10^{-6} (m2/s)
c_a = reference-concentration at bottom (-)
= 0.015 D_{50} + 1.5 $D_*^{-0.3}\ a^{-1}$
a = reference-level = 0.01 h (m)
F = suspension-parameter (-)
= $(0.01^{Z'} - 0.01^{1.2})/0.99^{Z'}\ (1.2 - Z')$
Z' = Z + φ = suspension-number (-)
Z = $W_s/\kappa u_*$ (-)
W_s = fall velocity grains (m/s)
φ = modification-parameter (-)
= 2.5 $(W_s/u_*)^{0.8}\ (c_a/0.65)^{0.4}$

The admissable transport is dependent on a somewhat subjective judgement, it is assumed in this analysis that a transport of 1.10^{-5} m/s is almost negligible compared to the "normal" tidal transport (in the order of 10^{-3} m2/s) and therefore this transport is allowable in the reclamation fields.
From report LAY-OUT part I (lit. (12)) follows also the representative current-velocity inside the fields, which is in the order of U = 0.4 m/s.

For the allowable wave-height it now can be found:

waterdepth (m)	1	2	3	4
admissable transport S (m2/s)	1.10^{-5}	1.10^{-5}	1.10^{-5}	1.10^{-5}
admissable shear-stress τ (N/m2)	0.28	0.28	0.28	0.28
shear-stress current τ_c' (N/m2)	0.19	0.19	0.19	0.19
shear-stress wave $\hat{\tau}_w$ (N/m2)	0.18	0.18	0.18	0.18
admissable wave-height (period):	0.08 m (<2 s)	0.15 m (<2 s)	0.28 m 0.17 m (<2 s) (3 s)	0.25 m (<3 s)

Table 4.1: admissable wave-height inside the reclamation fields, dependent on the water-depth



4.1

Diffraction coefficients

4.2 Opening-width and wave-diffraction

The width of the opening is dependent on the wave-action which is assumed admissable inside the fields.
From par. 4.1 it follows, that the undisturbed wave-climate (see table 3.5.a and b) is much to heavy to ensure the settlement of sediments in the reclamation-basins. Thus a longitudinal dam at the seaward end of the fields will be necessary. The width of the openings, which are necessary in order to allow the tidal motion to enter the fields, is determined by the diffracted wave-pattern of the waves, which come from the SE, E, SW and S-direction (in case of offshore winds, the longitudinal dam has hardly any influence on the wave-pattern inside, apart from some reflection against the dam).

From table 3.4.1 to p it shows that the heavy wave-action mainly originates from E, SE, S and SW-direction (long fetch-lengths).

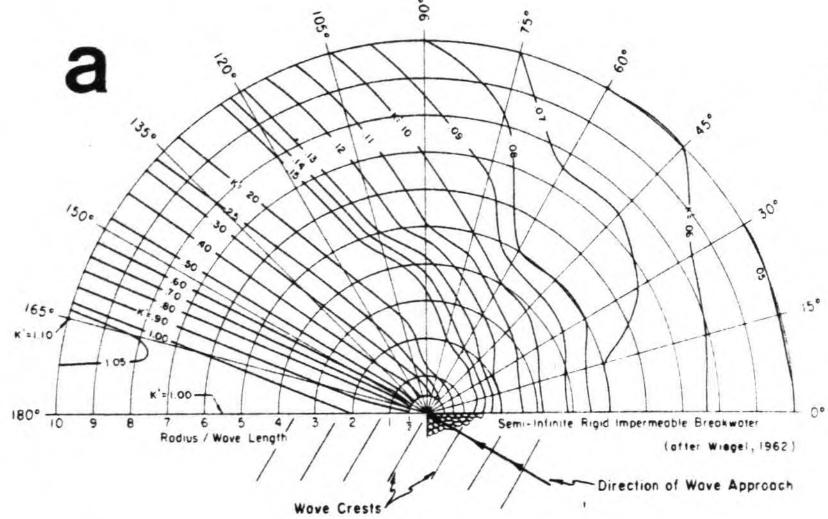
The diffracted wave-pattern is dependent on the size of the opening, relative to the wave-length of the waves, which is determined by the wave-period.
The opening-size must at least be 150 m, in order to avoid too large velocities inside the opening (due to the tidal motion).

In table 3.1. a to p it shows that the largest part of the waves (90°) has a period of less than 6 s, which coincides with a wave-length of about 40 m. Considering a gapwidth of 150 m or more, this is equal to a gapwidth of 4L or more. From the shore protection manual (lit. (6)) the diffracted wave-pattern can be found (see Fig. 4.1). It shows that the geometric shadowline forms the border between the area with undisturbed waves ($K' = 1.0$) and hardly any waves ($K' < 0.20$); since the size of the basin is rather large compared with the wave-length.

In case the waves approach the basins from a direction which is not perpendicular, the relative opening is smaller (according to geometric, the relative opening for a 45°-approach is $B_{45} = \frac{1}{2}\sqrt{2}.B_0$).
However, again the shadow lines border the area with the undisturbed waves, between the calm areas (see Fig. 4.2).

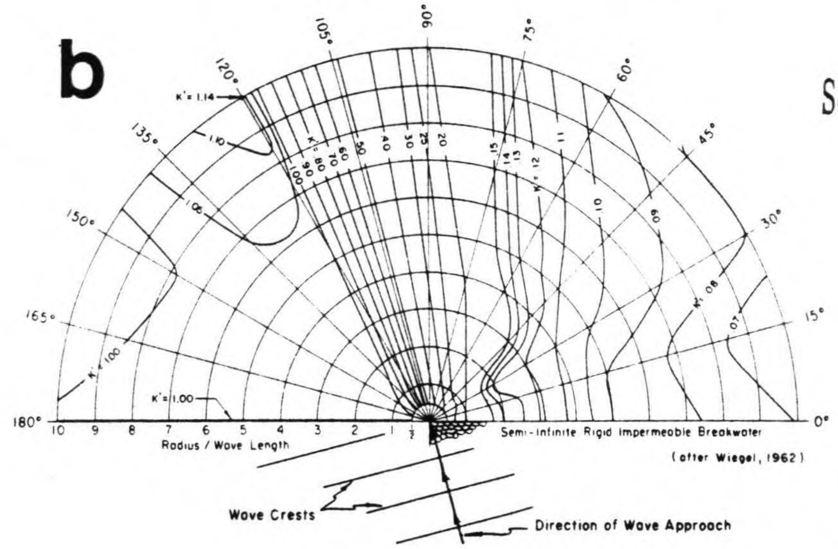
a

East-direction (60°)



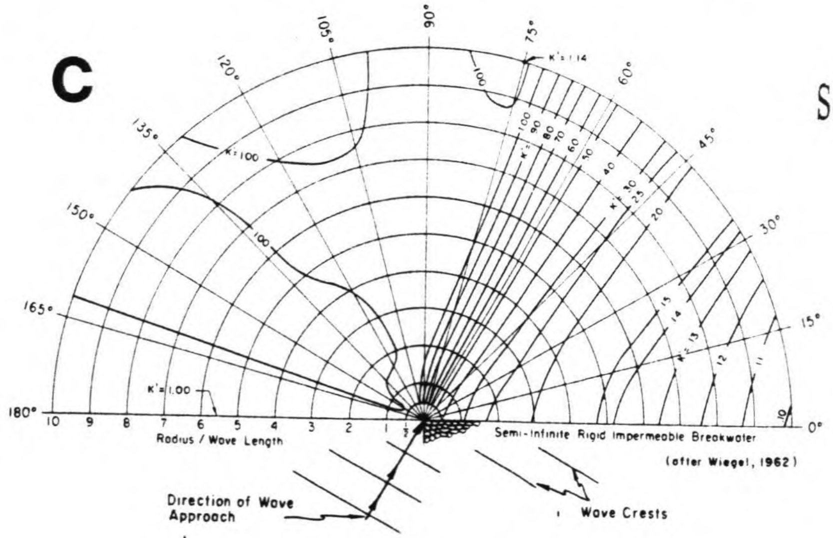
b

South-East-direction (15°)



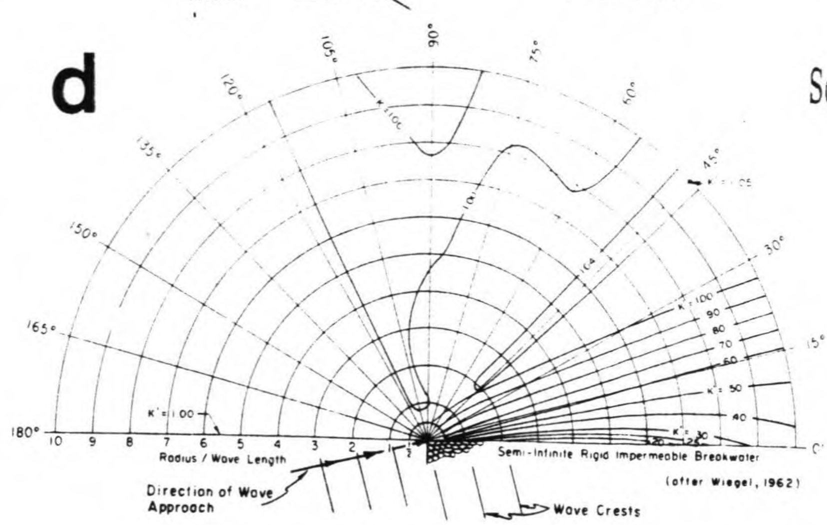
c

South-direction (-30°)



d

South-West-direction (-75°)



4.2

Diffraction-coefficients for waves which approach the coast under an angle

Roughly approximated, the size of the opening is directly proportional to the area with the original wave-climate (the same as the area "outside" the reclamation-fields), due to the short periods of the larger part of the waves.

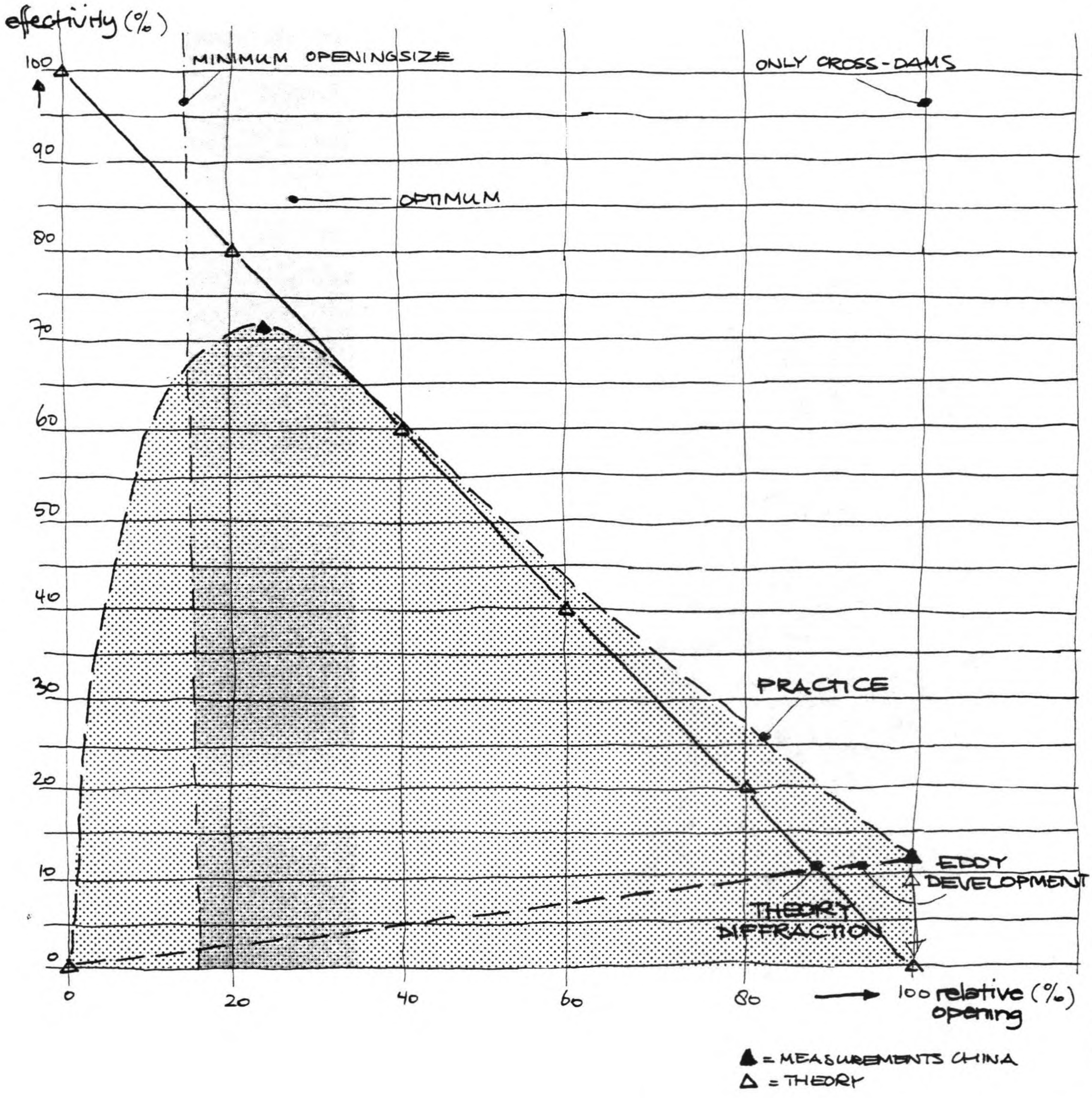
THEORY

If the efficiency of the longitudinal dike with openings is compared with the natural situation (no dikes), the result is shown in Fig. 4.3. The natural situation is assumed to have an efficiency of 0%, a longitudinal dike without openings is assumed to have an effect of 100%.
In practice the largest effect which could be realized is in the order of 80%, since the minimum opening-size is 150 m (considering a distance between the cross-dams of 1,000 m).

PRACTICE

In the region of the small opening-sizes, the advantageous influence of the small opening on the wave-climate is reduced by the disadvantageous influence of the small opening on the stream pattern and thus the sedimention-pattern. This influence is also shown in Fig. 4.3, if the dike would contain no opening at all, its effectivity would also be 0%, since no water (sediments) can enter the basin. In LAY-OUT part I it has been shown that the eddy-development also has an advantageous influence on the effectivity of the basins, so the effect of an opening of 100% is in practice not 0%, but around 12% (measurements done bij S.B.W.C. conform these findings: the sedimentation of a test-area with cross-dams only (opening 100%) was found to be about 12% of the total storage-quantity, a test-area with cross-dams and a longitudinal dam with an opening of about 25% was found to result in a sedimentation of 70% of the storage-quantity).

It must be stressed that Fig. 4.3 is mainly based on rough estimations, some measurements or tests in situ should be conducted in order to confirm these findings.
Fig. 4.3 only shows the tendency of the influence of the opening-width.



4.3

Opening-width in relation to the effectivity of the longitudinal dike

4.3 Dimensions of the fields and fetch-length

In the report LAY-OUT part I (lit. (12)) it was found that with respect to the tidal motion, a reclamation field should be as wide as possible (distance between the cross-dams as large as possible) and as short as possible (length of the cross-dams in the order of 500 m). The wave-action from outside the reclamation-area (SE, E, S, SW-direction) is sufficiently reduced by a planned longitudinal dike. From the point of costs, it would be economical to create an inner area as large as possible; i.e. a large distance between coast-line and longitudinal dam (not 500 m, but in the order of 2,000 m).

However, considering the admissable wave-action inside the fields, these distances are limited by the allowable fetch-length for wind-waves; since the wind will cause wave-action inside the fields.

Table 4.2. a and b show the distribution of wind-speed at the Cao Jing district (see also table 3.1. a to p).
From this table it follows:

	non-flood season	flood season
- average wind-speed U (m/s)	7.16	6.72
- 10%-wind-speed $U_{0.10}$ (m/s)	12.5	11
- 1%-wind-speed $U_{0.01}$ (m/s)	18.5	16.5

Table 4.3: typical wind-speed at Cao Jing district

For each wind-direction, the distribution of the wind-speed is more or less the same, so for the dimension of the fields, there is not any specific direction in which the fields should be shorter or longer, with respect to the wind-generated wave-action.

NON FLOOD season	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	TOTAL
direction:							
N	2.92	9.75	17.8	4.95	0.87	*	36.71
NE	1.07	6.43	10.9	3.51	*	*	21.90
E	0.52	4.23	2.79	2.73	*	*	10.21
SE	0.48	2.87	2.02	0.12	*	*	5.43
S	0.04	1.45	2.94	*	*	*	4.44
SW	0.09	0.98	1.46	*	*	*	2.53
W	*	1.10	1.00	*	*	*	2.14
NW	0.49	3.42	7.97	2.45	0.21	*	14.63
TOTAL	5.61	30.23	46.88	13.76	1.08	*	98.0

Table 4.2.1: distribution of wind-speed during non-flood season, percentages of occurrence

FLOOD season	wind-speed (m/s) < 2	2-5	5-11	11-17	17-25	> 25	TOTAL
direction:							
N	1.35	2.53	7.43	2.28	0.14	0.12	13.92
NE	0.43	3.62	4.71	1.41	0.09	*	10.28
E	0.61	4.13	6.03	0.09	*	*	10.88
SE	1.00	5.65	5.92	1.69	0.05	*	14.37
S	0.97	9.53	15.63	0.89	*	*	27.98
SW	0.33	3.89	6.68	0.97	*	*	11.98
W	0.07	0.80	2.06	0.13	0.06	*	3.28
NW	0.31	0.82	1.66	1.40	0.12	*	4.56
TOTAL	5.07	30.97	50.12	8.86	0.46	0.12	97.3

Table 4.2.1: distribution of wind-speed during flood season, percentages of occurrence

In Fig. 3.4 a graph is shown which gives the relation between the wind-generated wave-height, wave-period and the wind-speed, dependent on the fetch-length. In can be found for shallow water (see table 4.3.a):

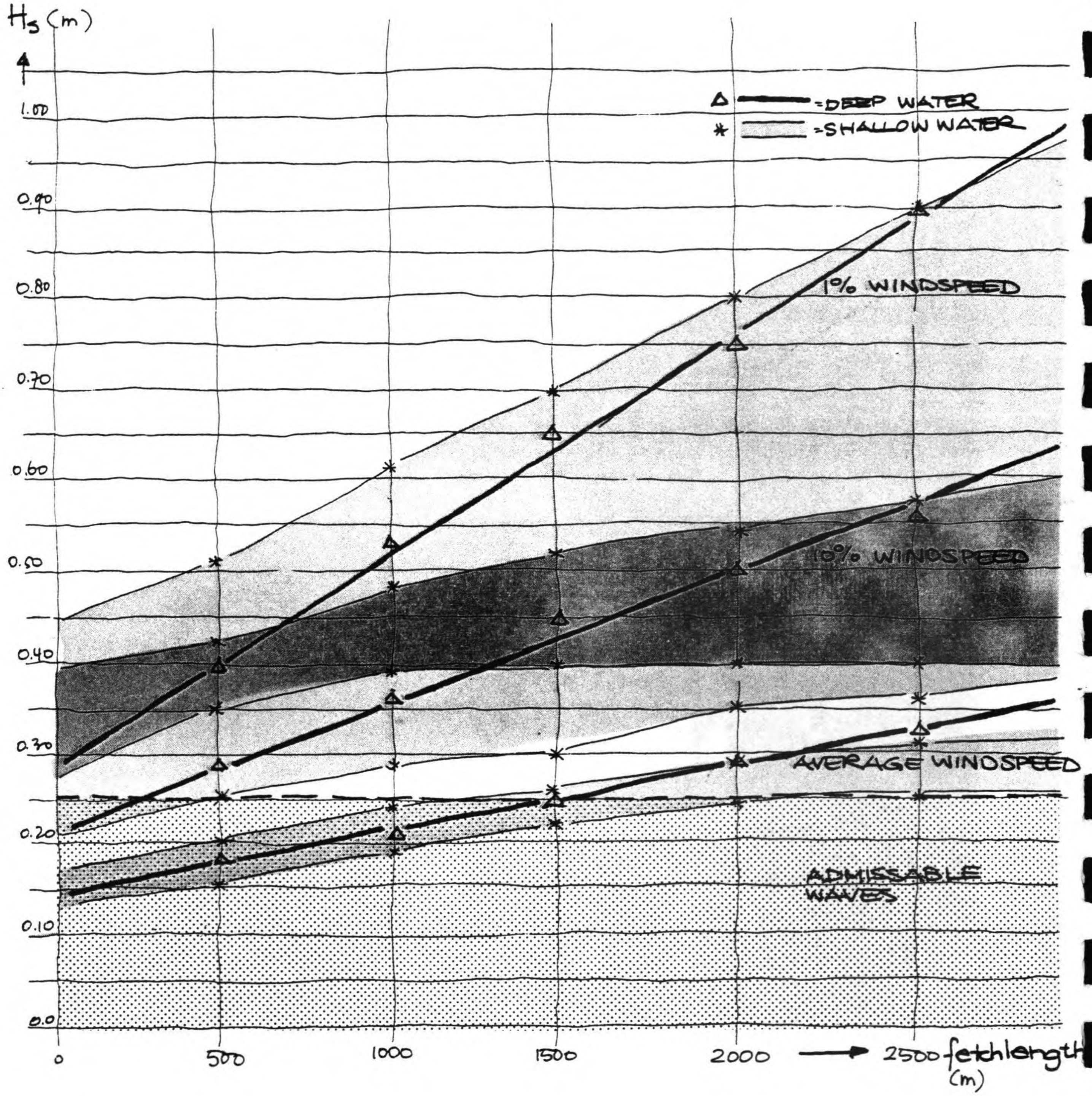
waterdepth		1 m	2 m	3 m	4 m	5 m
fetch-length		wave-height (m)				
- 500 m	$U = \bar{U}$	0.15 m	0.18 m	0.19 m	0.20 m	0.20 m
	$U = U_{0.10}$	0.25 m	0.30 m	0.38 m	0.40 m	0.42 m
	$U = U_{0.01}$	0.34 m	0.45 m	0.48 m	0.50 m	0.52 m
- 1,000 m	$U = \bar{U}$	0.18 m	0.20 m	0.22 m	0.24 m	0.24 m
	$U = U_{0.10}$	0.27 m	0.34 m	0.44 m	0.48 m	0.50 m
	$U = U_{0.01}$	0.36 m	0.48 m	0.52 m	0.60 m	0.66 m
- 1,500 m	$U = \bar{U}$	0.21 m	0.24 m	0.25 m	0.26 m	0.26 m
	$U = U_{0.10}$	0.30 m	0.38 m	0.48 m	0.50 m	0.52 m
	$U = U_{0.01}$	0.37 m	0.53 m	0.56 m	0.68 m	0.74 m
- 2,000 m	$U = \bar{U}$	0.23 m	0.26 m	0.27 m	0.28 m	0.28 m
	$U = U_{0.10}$	0.33 m	0.40 m	0.50 m	0.52 m	0.53 m
	$U = U_{0.01}$	0.38 m	0.56 m	0.62 m	0.76 m	0.80 m
- 2,500 m	$U = \bar{U}$	0.25 m	0.28 m	0.29 m	0.29 m	0.30 m
	$U = U_{0.10}$	0.33 m	0.43 m	0.52 m	0.59 m	0.55 m
	$U = U_{0.01}$	0.39 m	0.58 m	0.68 m	0.78 m	0.85 m
- 3,000 m	$U = \bar{U}$	0.26 m	0.28 m	0.30 m	0.30 m	0.30 m
	$U = U_{0.10}$	0.33 m	0.46 m	0.54 m	0.64 m	0.65 m
	$U = U_{0.01}$	0.40 m	0.60 m	0.75 m	0.80 m	0.90 m

Table 4.3.a: significant wave-height generated by wind, dependent on the waterdepth and wind-speed
SHALLOW WATER-theory

The same can be done for "deep water" (in order to determine the maximum wave which will develop at a certain fetch-length, see table 4.3.b) see Fig. 3.2.

fetch-length	500 m	1,000 m	1,500 m	2,000 m	2,500 m	3,000 m
	wave-height (m)					
$U = \bar{U}$	0.18 m	0.20 m	0.25 m	0.28 m	0.32 m	0.35 m
$U = U_{0.10}$	0.28 m	0.37 m	0.45 m	0.50 m	0.55 m	0.60 m
$U = U_{0.01}$	0.40 m	0.54 m	0.65 m	0.75 m	0.90 m	1.00 m

Table 4.3.b: significant wave-height generated by wind, dependent on the waterdepth and wind-speed;
DEEP WATER-theory



4.4

Fetch-length in relation to the wave-height

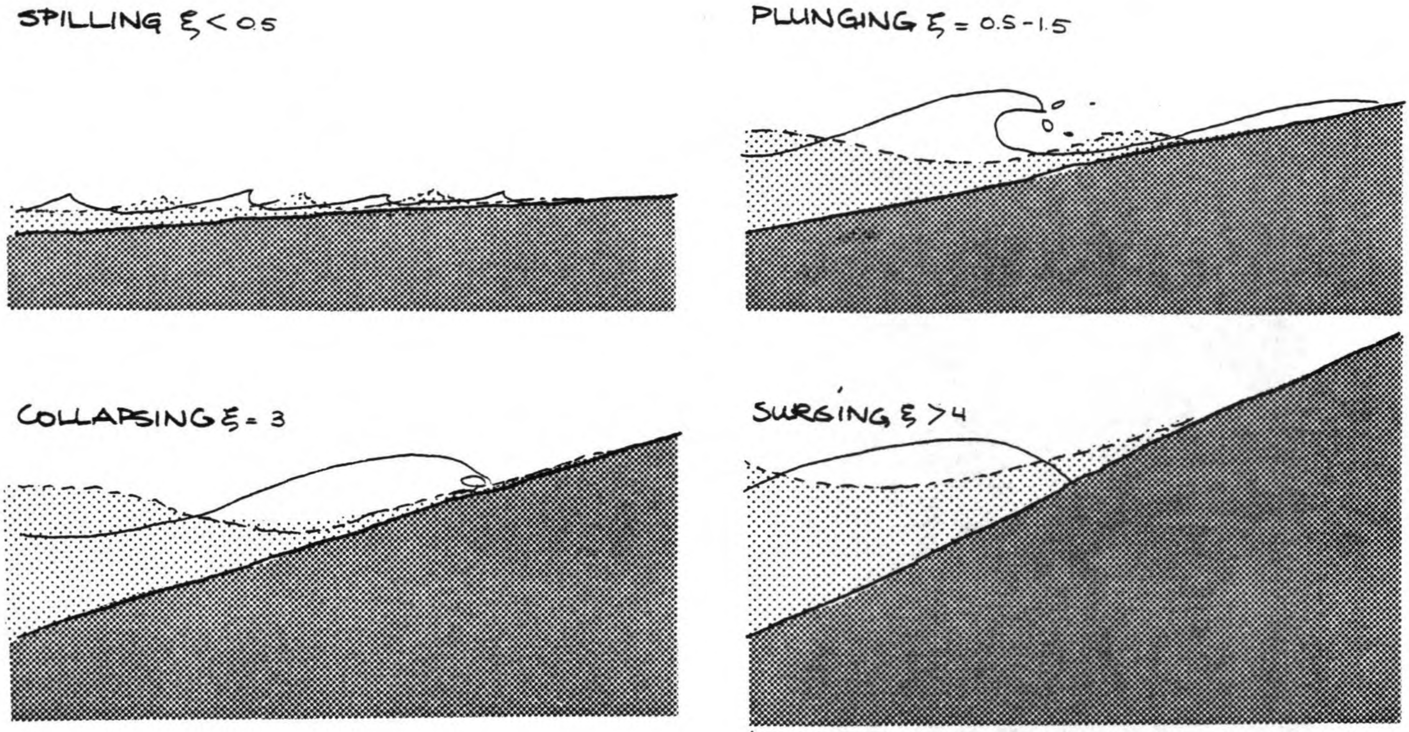
In Fig. 4.4 a graphical interpretation of table 4.3.a and b is given. It is obvious that the wave-action increases with increasing dimension of the fields.

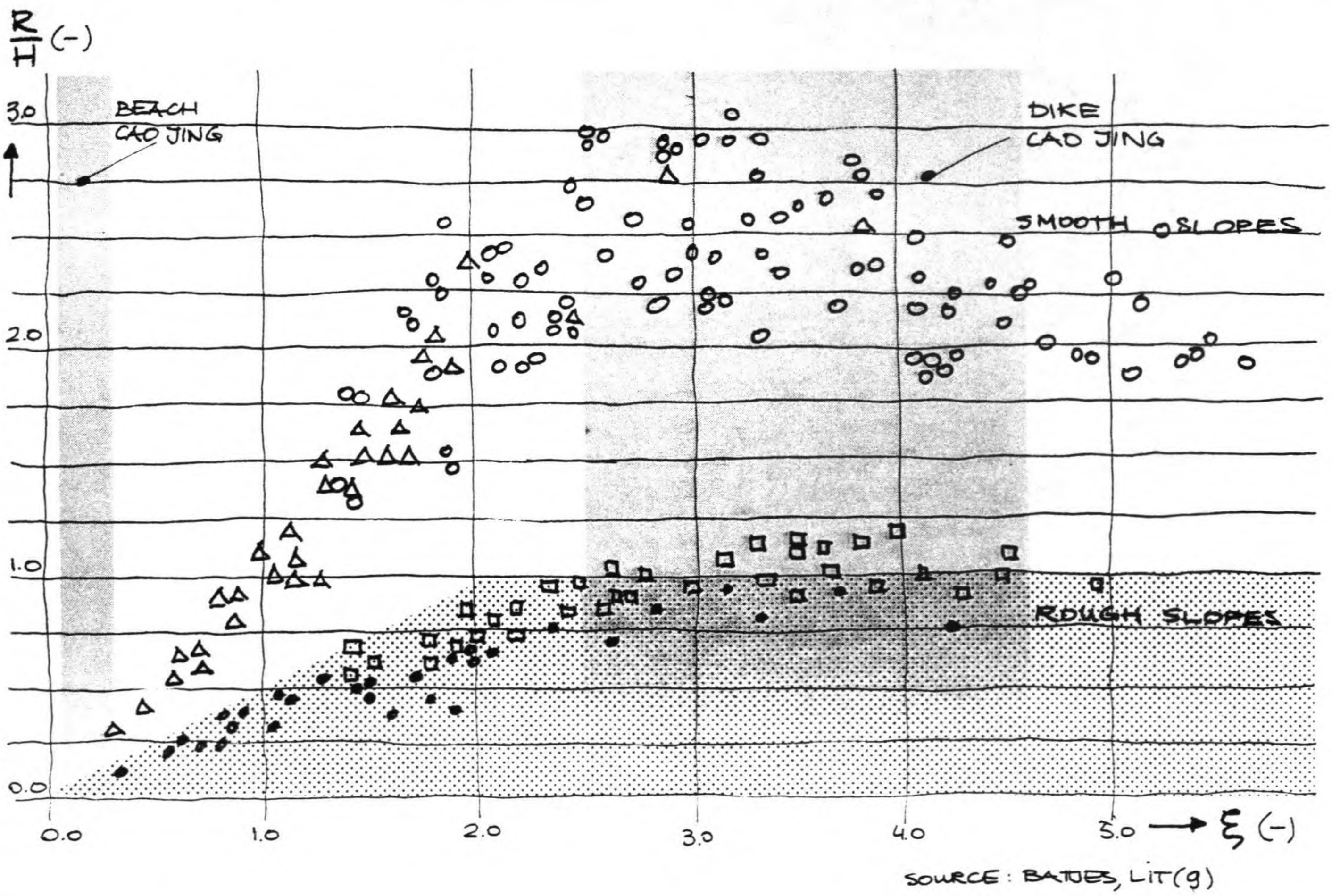
From par. 4.1 it can be concluded that a wave-height higher that 0.25 m is not admissable inside the reclamation-fields (see also Fig. 4.4). This limitation of the wave-height is rather strict, since the transport caused by a wave of the double wave-height is considerably higher (the concentration inside the field then is about half the tidal concentration, so the transport will be about 50% of the tidal transport too) the effectivity of the project would be considerably reduced by allowing a wave-height of 0.50 m (by the average wind).

The maximum admissable fetch-length is chosen in such a way, that the average wind-speed may not cause waves inside the basins, higher than 0.25 m. Fig. 4.4 shows the resulting fetch-length: a maximum of 1,500 m.

The distance between the cross-dams should therefore be smaller than 1,500 m.
The length of the fields differs with the upcoming tide; table 4.3.a shows that the length should in any case not exceed 2,000 m (when the tidal level causes a waterdepth of 1 m, the fetch-length is about 500 m, at 2 m waterdepth the fetch-length is about 1,000 m, at 3 m 1,500 m and at 4 m 2,000 m).
Thus the planned location of the longitudinal dike, at a bottom-level of +1.0 m (Wusong), see Fig. 3.3 is acceptable with respect to the admissable fetch-length.

N.B. If the average wind-speed causes waves of 0.25 m high, (these waves give rise to a transport-rate of about 1% of the tidal transport).
The 10% wind-speed causes waves of 0.50 m high (these waves give rise to a transport-rate of about 50% of the tidal transport).
So the accepted "loss" of sedimented material (caused by waves) is in the order of 10% of the total storage-quantity.





4.5

Wave-runup

4.4 Height of the dikes and wave-transmission

In the foregoing, it has been assumed that the longitudinal dike reduced the wave-height of the incoming waves (especially from SE, E, S and SW-direction) sufficiently. From the economic point of view however, it would be advisable to choose a dike-height as low as possible, which still reduces the wave-heights effectively. This reduction of the wave-height is dependent on the transmission of waves over the longitudinal dam.

Transmission of waves is only important in case of on-shore wave-directions (E, SE, S and SW), since we are interested to know the resulting wave-action inside the reclamation-fields.

The transmission-coefficient K_T (which gives the ratio transmitted wave-incoming wave) is only dependent on the original wave-height, the relative height of the obstacle, the width of the obstacle and the wave-steepness. In case of inpermeable break-waters (longitudinal dike) the formulae of Seelig (lit. (16), (22)) can be used:

$$K_T = \frac{H_t}{H_i} = C\left(1 - \frac{F}{R}\right) \text{ if } F > 0 \quad \text{(13a)}$$

$$K_T = \frac{H_t}{H_i} = C\left(1 - \frac{F}{R}\right) - (1 - 2C)\frac{F}{R} \text{ if } F \leq 0 \quad \text{(13b)}$$

in which

K_T = transmission coefficient (-)
H_t = transmitted wave-height (m)
H_i = incoming wave-height (m)
C = transmission-parameter (-)
  = $0.523 - 0.031\ B\ (1/(R-F))$
B = width of dike (m)
  = $B_o/\cos\beta$
B_o = width of dike perpendicular to coast-line (m)
β = angle of wave-approach with perpendicular axis (°)
R = wave-runup (m) = $R_o\cos\beta$
F = freeboard: the distance between dike-top and stillwater-level (m)

The wave-runup can be found from Ahrens (lit. (1)), the shore protection manual (lit. (6)), and Battjes (lit. (9)).
The wave-runup shows to be dependent on the breaker-index of the waves which reach the dike, for regular waves:

$R_o = 0.692\ \xi/(1 + 0.504\ \xi)\ H$ .... (14)

in which

R_o = wave-runup (m) (from perpendicular waves)
ξ = breaker-index (-)
= $\tan\theta/\sqrt{H/L_o}$)
θ = slope of dike-side (degr.)
H = incoming wave-height (m)
L_o = deep-water wave-length (m) (=1.56 T^2)

According to eq. (14), the wave-runup at the dike will vary between 1.0 and 1.2 (very long waves).
Battjes (lit. (9)) and Tanis (lit. (22)) advise to use R = H in such cases (see also Fig. 4.5).
As such the transmission-coefficients are only dependent on the incoming wave-height H and the relative freeboard (F) of the dike.

Following assumptions have been made:

- the width of the dike is yet unknown, for this analyses the width at the top is assumed to be about 1 m;

- the effect of wave-setup (increase of the water-level in front of the longitudinal dike due to wave-stress) is neglected; according to Tanis (lit. (22)) this wave-setup will be in the order of 0.1 m in case of "normal" wave-action (H_s = 1 m) and in the order of 0.25 m in case of extreme conditions (H_s = 2.5 m). In the scope of this analysis such elevations are too small compared with the discrete steps in the tidal level (1 m);

- the wave-runup for each wave-class is taken the average wave-height of each wave-class, otherwise the calculation would become too time-consuming (see table 4.4. a to d).

The transmission-coefficients have been calculated for the four main directions, see table 4.4.

E (β = 60°)	4	3.5	3	2.5	2	1.5	1	0.5	0	-0.5	-1	-1.5	-2
H (m) (R)	transmission-coefficients (-)												
<0.25 (0.13)	-	-	-	-	-	-	-	-	0.05	1.0	1.0	1.0	1.0
0.25-0.75 (0.25)	-	-	-	-	-	-	-	-	0.28	1.0	1.0	1.0	1.0
0.75-1.25 (0.50)	-	-	-	-	-	-	-	-	0.40	1.0	1.0	1.0	1.0
1.25-1.75 (0.75)	-	-	-	-	-	-	-	0.09	0.44	0.82	1.0	1.0	1.0
1.75-2.25 (1.00)	-	-	-	-	-	-	-	0.20	0.46	0.76	1.0	1.0	1.0
2.25-2.75 (1.25)	-	-	-	-	-	-	0.06	0.26	0.47	0.69	0.88	1.0	1.0
2.75-3.25 (1.50)	-	-	-	-	-	-	0.13	0.31	0.48	0.66	0.83	1.0	1.0
3.25-3.75 (1.75)	-	-	-	-	-	0.04	0.19	0.34	0.49	0.64	0.79	0.94	1.0
3.75-4.75 (2.13)	-	-	-	-	-	0.13	0.25	0.37	0.49	0.61	0.74	0.86	0.98

Table 4.4.a: transmission-coefficients versus relative freeboard, in case of waves approaching from the East-direction

SE (β = 15°)	4	3.5	3	2.5	2	1.5	1	0.5	0	-0.5	-1	-1.5	-2
H (m) (R)	transmission-coefficients (-)												
<0.25 (0.24)	-	-	-	-	-	-	-	-	0.40	1.0	1.0	1.0	1.0
0.25-0.75 (0.49)	-	-	-	-	-	-	-	-	0.46	1.0	1.0	1.0	1.0
0.75-1.25 (0.97)	-	-	-	-	-	-	-	0.22	0.49	0.76	1.0	1.0	1.0
1.25-1.75 (1.46)	-	-	-	-	-	-	0.17	0.32	0.50	0.68	0.86	1.0	1.0
1.75-2.25 (1.94)	-	-	-	-	-	0.10	0.24	0.37	0.51	0.64	0.78	0.91	1.0
2.25-2.75 (2.42)	-	-	-	-	0.08	0.19	0.29	0.40	0.51	0.62	0.73	0.83	0.94
2.75-3.25 (2.95)	-	-	-	0.07	0.16	0.25	0.33	0.42	0.51	0.60	0.69	0.78	0.87
3.25-3.75 (3.40)	-	-	0.05	0.13	0.21	0.28	0.36	0.44	0.51	0.59	0.67	0.74	0.82
3.75-4.75 (4.12)	0.01	0.07	0.13	0.20	0.26	0.32	0.39	0.45	0.52	0.58	0.64	0.71	0.77

Table 4.4.b: transmission-coefficients versus relative freeboard, in case of waves approaching from the South-East-direction

S (β = -30°)	4	3.5	3	2.5	2	1.5	1	0.5	0	-0.5	-1	-1.5	-2
H (m) (R)	transmission-coefficients (-)												
<0.25 (0.22)	-	-	-	-	-	-	-	-	0.36	1.0	1.0	1.0	1.0
0.25-0.75 (0.44)	-	-	-	-	-	-	-	-	0.44	1.0	1.0	1.0	1.0
0.75-1.25 (0.87)	-	-	-	-	-	-	-	0.17	0.48	0.79	1.0	1.0	1.0
1.25-1.75 (1.31)	-	-	-	-	-	-	0.10	0.30	0.50	0.74	0.89	1.0	1.0
1.75-2.25 (1.74)	-	-	-	-	-	0.05	0.20	0.35	0.50	0.65	0.80	0.95	1.0
2.25-2.75 (2.18)	-	-	-	-	0.03	0.15	0.27	0.39	0.51	0.63	0.75	0.87	0.99
2.75-3.25 (2.61)	-	-	-	0.01	0.11	0.21	0.31	0.41	0.51	0.61	0.71	0.81	0.91
3.25-3.75 (3.05)	-	-	0.01	0.08	0.17	0.25	0.34	0.43	0.51	0.60	0.68	0.77	0.85
3.75-4.75 (3.68)	-	0.02	0.09	0.16	0.23	0.30	0.37	0.44	0.51	0.58	0.65	0.73	0.80

Table 4.4.c: transmission-coefficients versus relative freeboard, in case of waves approaching from the Southern-direction

SW (β = -75°)	4	3.5	3	2.5	2	1.5	1	0.5	0	-0.5	-1	-1.5	-2
H (m) (R)	transmission-coefficients (-)												
<0.25 (0.07)	-	-	-	-	-	-	-	-	-	1.0	1.0	1.0	1.0
0.25-0.75 (0.13)	-	-	-	-	-	-	-	-	-	1.0	1.0	1.0	1.0
0.75-1.25 (0.26)	-	-	-	-	-	-	-	-	0.06	1.0	1.0	1.0	1.0
1.25-1.75 (0.39)	-	-	-	-	-	-	-	-	0.21	1.0	1.0	1.0	1.0
1.75-2.25 (0.52)	-	-	-	-	-	-	-	-	0.29	0.98	1.0	1.0	1.0
2.25-2.75 (0.65)	-	-	-	-	-	-	-	-	0.34	0.87	1.0	1.0	1.0
2.75-3.25 (0.78)	-	-	-	-	-	-	-	0.07	0.37	0.79	1.0	1.0	1.0
3.25-3.75 (0.91)	-	-	-	-	-	-	-	0.10	0.39	0.75	1.0	1.0	1.0
3.75-4.75 (1.11)	-	-	-	-	-	-	0.05	0.18	0.42	0.70	0.95	1.0	1.0

Table 4.4.d: transmission-coefficients versus relative freeboard, in case of waves approaching from the South-West-direction

Now the transmission-coefficients are known, the transmitted wave-heights can be calculated for several possible dike-heights. It has been chosen to calculate the wave-pattern for (bottom-level dike: +1.00 m (Wusong-level):

dike-height 2.0 m, top at: +3.00 m (Wusong)
dike-height 2.5 m, top at: +3.50 m (Wusong)
dike-height 3.0 m, top at: +4.00 m (Wusong)
dike-height 3.5 m, top at: +4.50 m (Wusong)
dike-height 4.0 m, top at: +5.00 m (Wusong)
dike-height 4.5 m, top at: +5.50 m (Wusong)

In order to determine a relation between the dike-height and the effectivity of this (longitudinal) dike, the transmitted wave-pattern is important, in case of on-shore winds. The wind-generated waves inside the reclamation-basins are not influenced by the height of the longitudinal dike.

The transmitted waves are shown in table 4.5. a to h, for the six different dike-heights.
A distinction should be made between the flood season and the non-flood season, since the wave-distribution (especially from the SE, E, SW and S-direction) is considerable different during each season.

Also a distinction should be made between the several (tidal) still water-levels outside, since the transmission is dependent on the relative freeboard.
For this reason, the tidal motion is schematized in 6 discrete (tidal) levels; the waterdepth at the planned dike-trace is therefore schematized in 5 discrete depths.

NON-FLOOD SEASON

E dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	2.71	2.71	2.71	2.71	2.71	2.71
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	3.01	5.73	5.73	5.73	5.73	5.73
0.25-0.75	2.36					
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	1.06	1.06	3.36	5.88	6.15	6.15
0.25-0.75	2.30	2.30	2.46	0.27		
0.75-1.25	1.91	2.25	0.32			
1.25-1.75	0.61	0.51	0.01			
1.75-2.25	0.27	0.03				
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	*	*	*	*	*	*
0.25-0.75						
0.75-1.25		(H_s = 2.0) extreme situation K_T =				
1.25-1.75	1	1	1	0.76	0.46	0.20
1.75-2.25						

Table 4.5.a: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the non-flood season

NON-FLOOD SEASON

SE dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	13.35	13.35	13.35	13.35	13.35	13.35
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	2.08	5.69	8.38	10.76	10.76	10.76
0.25-0.75	6.50	5.05	2.38			
0.75-1.25	2.13					
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	0.60	0.60	1.75	4.91	6.51	7.80
0.25-0.75	1.96	3.40	4.88	3.39	2.39	0.96
0.75-1.25	3.90	4.13	2.56	1.46	0.31	
1.25-1.75	2.62	1.63	0.56			
1.75-2.25	0.67					
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	*	*	*	*	*	*
0.25-0.75						
0.75-1.25		extreme condition (H_s = 2 m); K_T =				
1.25-1.75	1.0	0.91	0.78	0.64	0.51	0.37
1.75-2.25						

Table 4.5.b: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the non-flood season

NON-FLOOD SEASON

S dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	5.76	5.76	5.76	5.76	5.76	5.76
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	1.64	3.96	5.77	5.77	5.77	5.77
0.25-0.75	3.23	1.81				
0.75-1.25	0.91					
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	0.46	0.46	1.45	3.84	5.52	5.52
0.25-0.75	1.39	2.20	4.88	1.31		
0.75-1.25	2.31	3.01	1.03	0.37		
1.25-1.75	0.83	0.82	0.17			
1.75-2.25	0.33					
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	*	*	*	*	*	*
0.25-0.75			extreme condition ($H_s \approx 2,0$)			
0.75-1.25				K_T		
1.25-1.75	0.99	0.95	0.80	0.65	0.50	0.35
1.75-2.25						

Table 4.5.c: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the non-flood season

NON-FLOOD SEASON

SW dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	0.32	0.32	0.32	0.32	0.32	0.32
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	0.71	0.71	0.71	0.71	0.71	0.71
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	0.28	0.28	1.05	1.05	1.05	1.05
0.25-0.75	0.62	0.62				
0.75-1.25	0.15	0.15				
1.25-1.75						
1.75-2.25						
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	*	*	*	*	*	*
0.25-0.75			extreme condition ($H_s \approx 2.0$)			
0.75-1.25				K_T		
1.25-1.75	1.0	1.0	1.0	0.98	0.29	
1.75-2.25						

Table 4.5.d: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the non-flood season

FLOOD SEASON

E dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	2.40	2.40	2.40	2.40	2.40	2.40
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	3.24	4.20	4.20	4.20	4.20	4.20
0.25-0.75	1.64					
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	0.89	0.89	3.64	5.71	6.02	6.02
0.25-0.75	2.75	2.75	2.04	0.30		
0.75-1.25	1.74	1.92	0.32			
1.25-1.75	0.33	0.42	0.01			
1.75-2.25	0.30	0.03				
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	0.84	0.84	0.84	0.84	3.89	6.72
0.25-0.75	3.05	3.05	3.05	3.05	2.78	0.28
0.75-1.25	2.29	2.29	2.29	2.59	0.32	0.05
1.25-1.75	0.54	0.54	0.54	0.50	0.06	
1.75-2.25	0.26	0.26	0.33	0.07		

Table 4.5.e: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the flood season

FLOOD SEASON

SE dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	30.72	30.72	30.72	30.72	30.72	30.72
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	6.08	13.58	26.07	26.07	26.07	26.07
0.25-0.75	14.85	13.21				
0.75-1.25	5.87					
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	1.16	1.16	3.89	12.20	14.25	19.72
0.25-0.75	5.06	7.89	10.39	6.24	7.44	2.98
0.75-1.25	7.92	8.95	6.36	4.25	0.98	
1.25-1.75	6.43	4.67	1.79			
1.75-2.25	2.10					
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	1.08	1.08	1.08	1.08	3.38	10.97
0.25-0.75	3.91	3.91	3.91	6.74	9.83	5.86
0.75-1.25	5.98	5.98	8.49	8.64	5.11	3.44
1.25-1.75	4.47	5.34	4.76	2.90	2.06	0.83
1.75-2.25	4.93	4.06	2.12	1.01		

Table 4.5.f: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the flood season

FLOOD SEASON

S dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	30.45	30.45	30.45	30.45	30.45	30.45
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	8.74	21.0	31.0	31.0	31.0	31.0
0.25-0.75	17.24	10.0				
0.75-1.25	5.02					
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	2.26	2.26	8.18	21.31	26.42	28.73
0.25-0.75	9.30	13.27	15.78	6.70	4.75	2.47
0.75-1.25	11.47	11.08	5.73	2.96		
1.25-1.75	5.80	4.56	1.48			
1.75-2.25	2.35					
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	2.06	2.06	2.06	2.06	5.34	21.07
0.25-0.75	9.02	9.02	9.02	9.02	18.04	6.74
0.75-1.25	9.99	9.99	11.42	11.00	5.40	2.33
1.25-1.75	4.63	5.12	5.55	3.66	1.85	0.50
1.75-2.25	4.94	4.35	2.59	0.93		

Table 4.5.g: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the flood season

FLOOD SEASON

SW dike-height (m)	2.0	2.5	3.0	3.5	4.0	4.5
waterdepth: 1 m						
F:	1.0	1.5	2.0	2.5	3.0	3.5
wave-height (m)						
<0.25	1.65	1.65	1.65	1.65	1.65	1.65
0.25-0.75						
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 2 m						
F:	0.0	0.5	1.0	1.5	2.0	2.5
wave-height (m)						
<0.25	3.77	3.78	3.78	3.78	3.78	3.78
0.25-0.75	0.01					
0.75-1.25						
1.25-1.75						
1.75-2.25						
waterdepth: 3 m						
F:	-1.0	-0.5	0.0	0.5	1.0	1.5
wave-height (m)						
<0.25	0.98	0.98	5.14	5.21	5.21	5.21
0.25-0.75	3.30	3.30	0.07			
0.75-1.25	0.85	0.85				
1.25-1.75	0.07	0.07				
1.75-2.25						
waterdepth: 4 m						
F:	-2.0	-2.5	-1.0	-0.5	0.0	0.5
wave-height (m)						
<0.25	0.94	0.94	0.94	0.94	6.15	6.24
0.25-0.75	3.90	3.90	3.90	3.90	0.09	
0.75-1.25	1.32	1.32	1.32	1.32		
1.25-1.75	0.09	0.09	0.09	0.09		
1.75-2.25						

Table 4.5.h: wave-pattern, after refraction, shoaling and transmission (on-shore winds), percentages of occurrence during the flood season

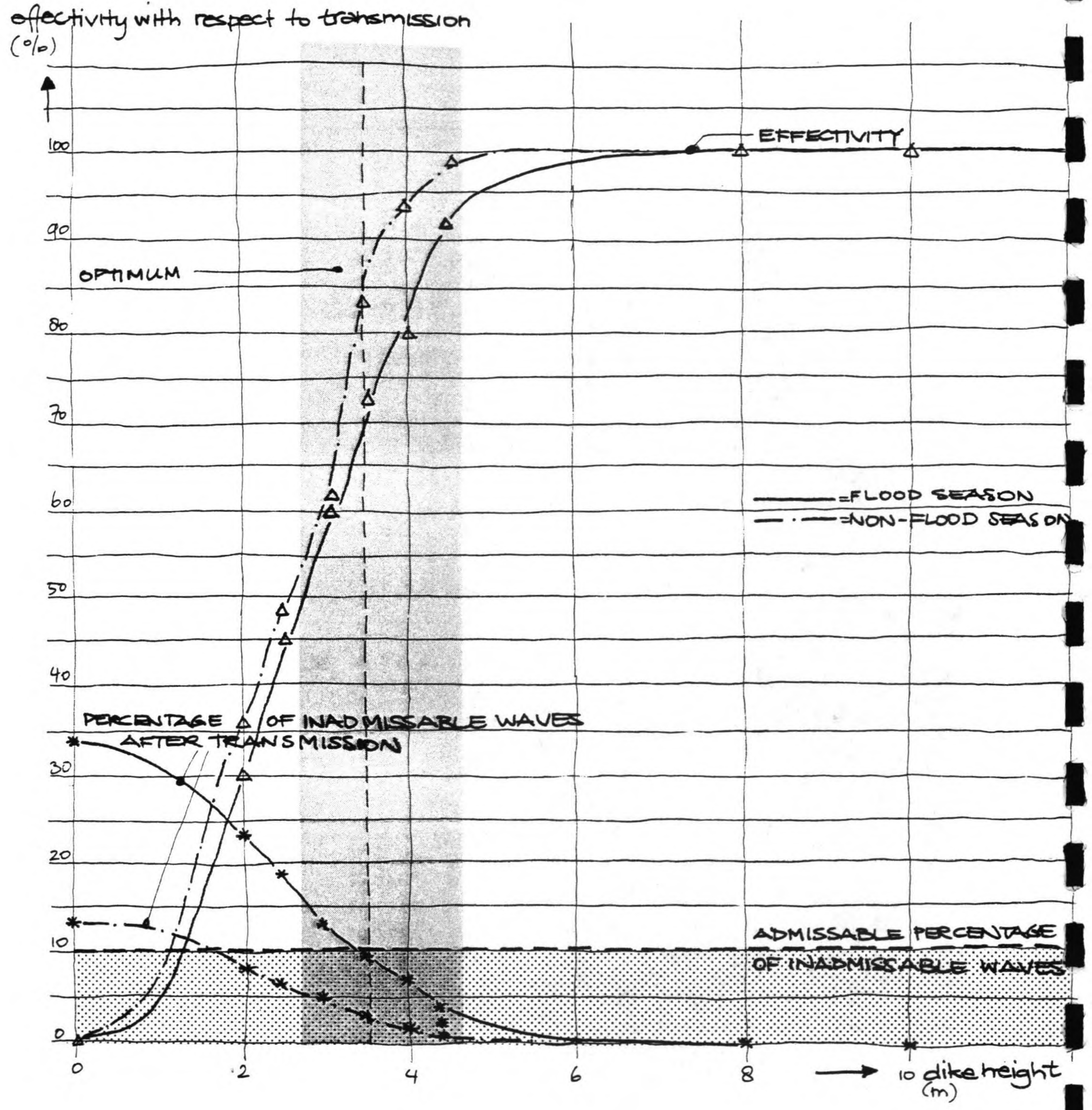
In order to compare the effectivity of each of the dike-heights, the duration of each of the tidal levels must also be taken into account.
All wave-heights above 0.25 are considered inadmissable, they will cause losses of sedimented material.
A comparison of the total percentages of inadmissable wave-heights, including the duration of the coinciding water-level is given in tables 4.6.a and b (duration in hours per day (average tidal motion).

NON-FLOOD dike-height (m)		0.0	2.0	2.5	3.0	3.5	4.0	4.5
water-level: 1 m duration: 4.3 h		percentages of occurrence (inadmissable waves)						
	E	1.92	0.0	0.0	0.0	0.0	0.0	0.0
17.9%	SE	12.48	0.0	0.0	0.0	0.0	0.0	0.0
	S	5.07	0.0	0.0	0.0	0.0	0.0	0.0
	SW	0.14	0.0	0.0	0.0	0.0	0.0	0.0
water-level: 2 m duration: 5.2 h		percentages of occurrence (inadmissable waves)						
	E	4.32	2.36	0.0	0.0	0.0	0.0	0.0
21.7%	SE	10.09	8.63	5.05	2.38	0.0	0.0	0.0
	S	5.20	4.14	1.81	0.0	0.0	0.0	0.0
	SW	0.43	0.0	0.0	0.0	0.0	0.0	0.0
water-level: 3 m duration: 6.3 h		percentages of occurrence (inadmissable waves)						
	E	5.09	5.09	5.09	2.79	0.27	0.0	0.0
26.3%	SE	9.16	9.15	9.16	8.00	4.85	3.24	0.96
	S	5.03	4.86	5.03	6.08	1.68	0.0	0.0
	SW	0.77	0.77	0.77	0.0	0.0	0.0	0.0
TOTAL %		13.13	8.51	6.76	4.95	1.79	0.85	0.25

Table 4.6.a: total percentage of inadmissable waves during the non-flood season versus the height of the dike (the dike is in-the-dry during 8.2 hours: 34.1%)

FLOOD dike-height (m)		0.0	2.0	2.5	3.0	3.5	4.0	4.5
water-level: 1 m duration: 3.2 h		percentages of occurrence (inadmissable waves)						
	E	1.74	0.0	0.0	0.0	0.0	0.0	0.0
13.3%	SE	28.99	0.0	0.0	0.0	0.0	0.0	0.0
	S	27.49	0.0	0.0	0.0	0.0	0.0	0.0
	SW	0.88	0.0	0.0	0.0	0.0	0.0	0.0
water-level: 2 m duration: 4.4 h		percentages of occurrence (inadmissable waves)						
	E	3.31	1.64	0.0	0.0	0.0	0.0	0.0
18.3%	SE	23.52	20.72	13.21	0.0	0.0	0.0	0.0
	S	28.57	22.26	10.0	0.0	0.0	0.0	0.0
	SW	2.61	0.01	0.0	0.0	0.0	0.0	0.0
water-level: 3 m duration: 3.9 h		percentages of occurrence (inadmissable waves)						
				5.12	2.37	0.30	0.0	0.0
	E	5.13	5.12	5.12	2.37	0.30	0.0	0.0
16.3%	SE	21.54	21.51	21.51	18.54	10.49	8.42	2.98
	S	28.94	28.92	28.91	22.99	9.66	4.75	2.47
	SW	4.23	4.22	4.22	0.07	0.0	0.0	0.0
water-level: 4 m duration: 2.5 h		percentages of occurrence (inadmissable waves)						
	E	6.19	6.14	6.14	6.23	6.23	3.16	0.33
10.4%	SE	19.84	19.29	19.29	19.28	19.29	17.00	9.33
	S	28.58	28.48	28.48	28.48	24.61	25.29	9.57
	SW	5.30	5.31	5.31	5.31	5.31	0.09	0.0
TOTAL %		34.53	24.1	18.6	13.3	9.1	6.9	2.9

Table 4.6.b: total percentage of inadmissable waves versus the height of the dike, during flood season
(the dike is 41.7% of 10 hours in-the-dry)



4.6

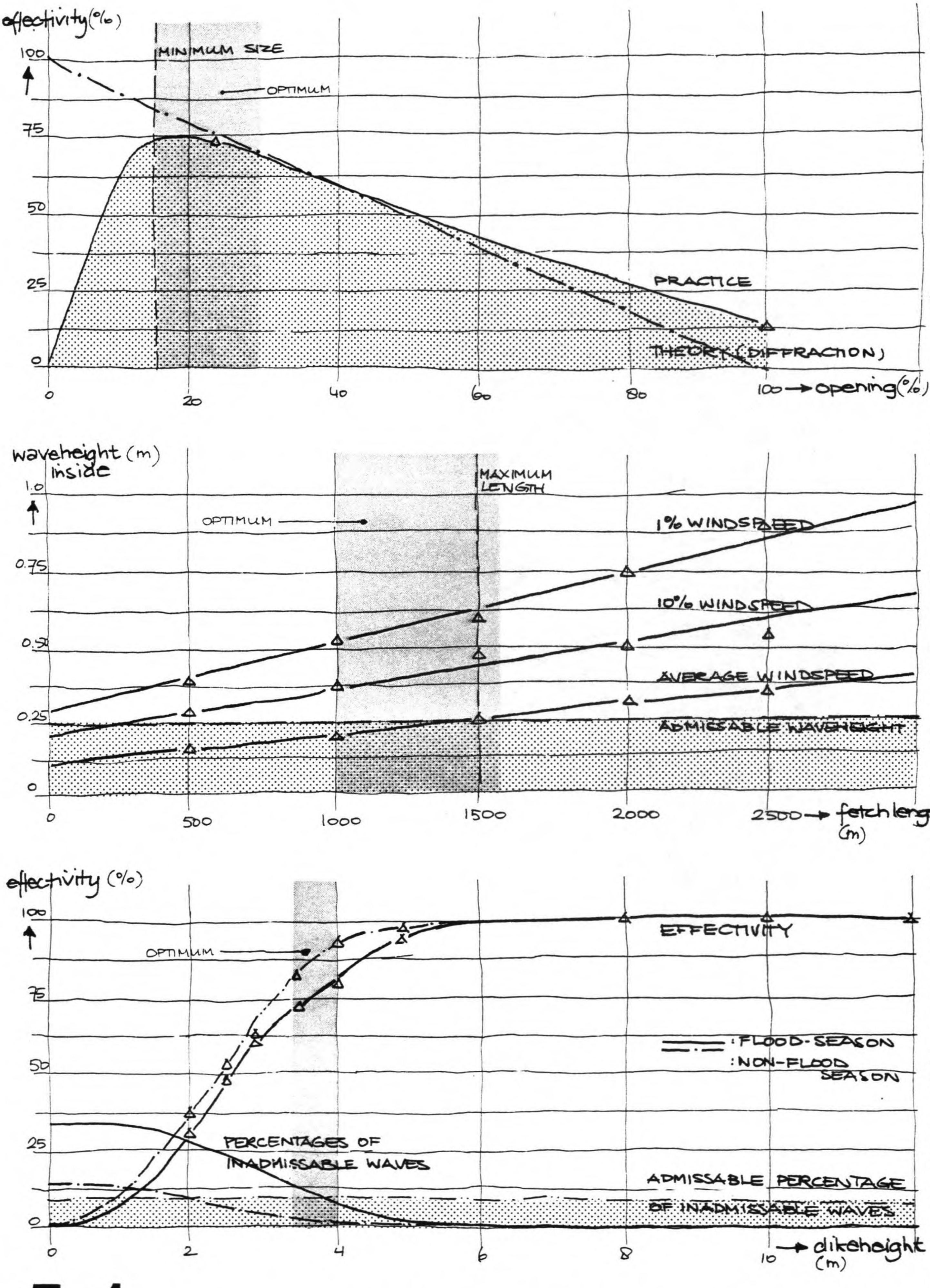
Dike-height in relation to the effectivity of the longitudinal dike

Fig. 4.6 shows a graphical interpretation of the results of the transmission-calculations. It shows that above a dike-height of 3 m, the increase of the effectivity decreases. Also the effect of a dike of 4 m is more or less the same as the effect of a dike of 6 m.

The same tendency is shown by the graph of the percentage of inadmissable wave-heights, the decrease of this percentage decreases when the height of the dike exceeds 3 m.

The optimum dike-height is thus to be found in the interval between 3 and 4 m. In this analysis it is chosen a criterion for the admissable percentage of "inadmissable" waves; this criterion is a maximum percentage of 10% (see Fig. 4.6).

The dike-height, which satisfies the 10%-criterion and lays in the range of the optimum dike-height is 3.5 m.



5.1 Relations between lay-out and wave-climate inside the fields

5. LAY-OUT DESIGN

5.1 Optimum lay-out design

From calculations with respect to the tidal motion (see LAY-OUT part I (lit. (12)) following conclusions could be drawn (wave-action not taken into account):

- opening-width as large as possible, the best lay-out would consist of cross-dams, with small longitudinal dams;

- length of the fields as short as possible: in the order of 500 m (the penetration of the sediment-concentration is in this order);

- distance between the cross-dams as large as possible: in the order of 1,000 m - 2,000 m.

From calculations with respect to the wave-action following conclusions can be drawn (see Fig. 5.1):

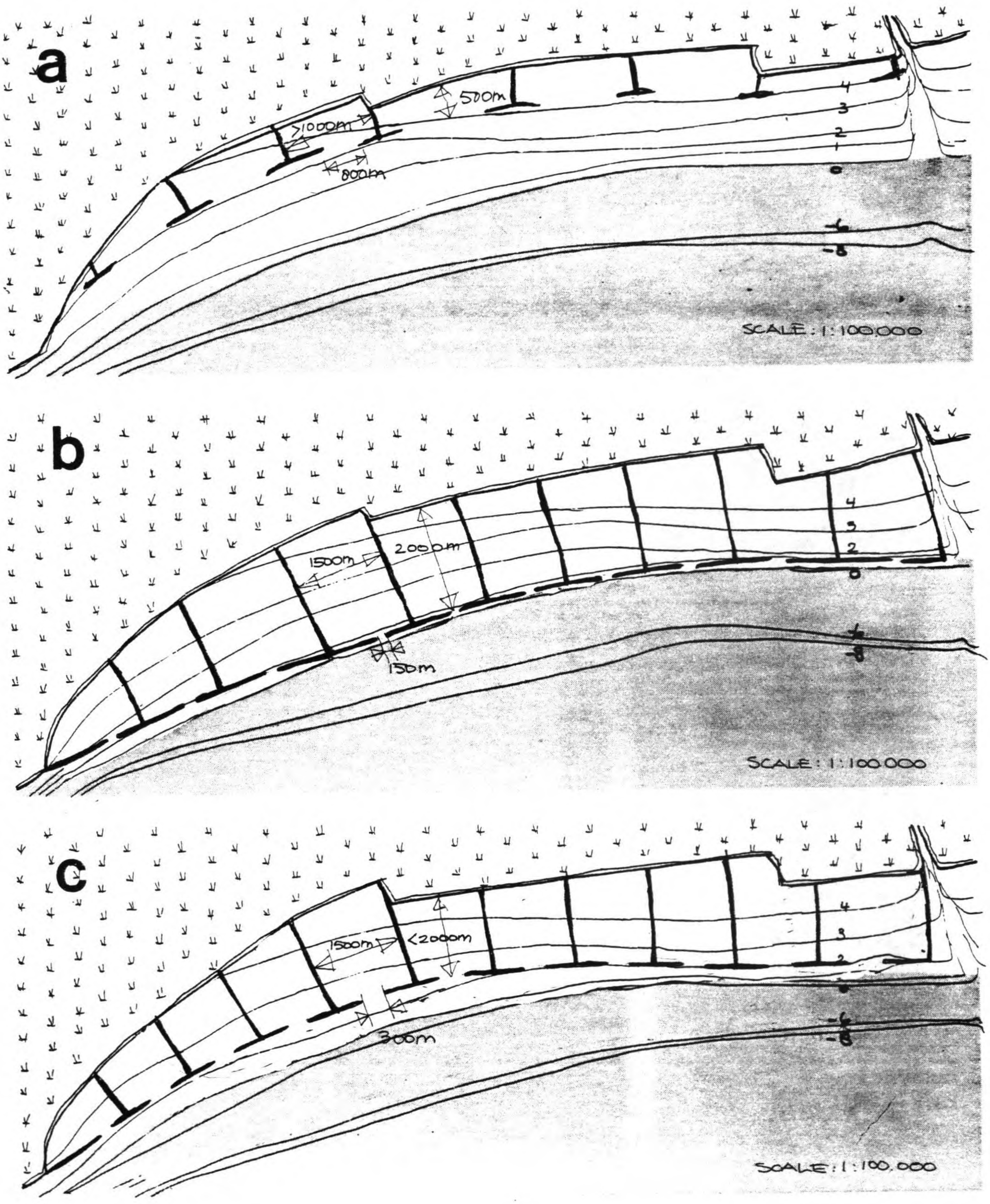
- opening-width as small as possible, the best lay-out would consist of a longitudinal dike with openings of about 10 à 20% of the total stretch;

- distance between the cross-dams not larger than 1,500 m; length of the fields in the order of 2,000 m (penetration of sediments is ensured by the wave-action);

- height of the dike about 3.50 m.

In Fig. 5.2 the solution with respect to the tidal motion is shown (A), also the solution with respect to the wave-climate (B). A combination forms the optimum solution for a lay-out design (C), taking into account the requirements found by the calculations.

N.B. In the report LAY-OUT part I (lit. (12)) was found that the longshore current causes the bigger part of water-exchange (DUCHESS) and sedimentation (MORPHOR). In case the opening at the seaward end is large the sedimentation by the current can become twice the storage-quantity.
By the wave-calculations in the analysis it shows that by the disturbing influence of the waves, in fact only 10% of the storage-quantity of sedimentation remains, in case of a large opening. So the tendency to create a small opening (to block the waves) is much stronger than the tendency to create a large opening (to allow the longshore current to enter). For this reason the optimum size of the opening is in the range of the small openings (10% to 30%).



5.2

Optimum lay-out design

With respect to the final design, following remarks can be made:

- the opening-width will be about 300 m, considering a distance between the cross-dams of 1,500 m (20%);

- the distance between the cross-dams should be about 1,500 m;

- the length at the fields may cover a maximum of 2,000 m, the trace of the longitudinal dike, which is planned at a bottom-level of +1 m, should not be constructed any further away from the coast.
  From the point of admissable waves, it would be better to construct the dike at a higher bottom-level (1+);

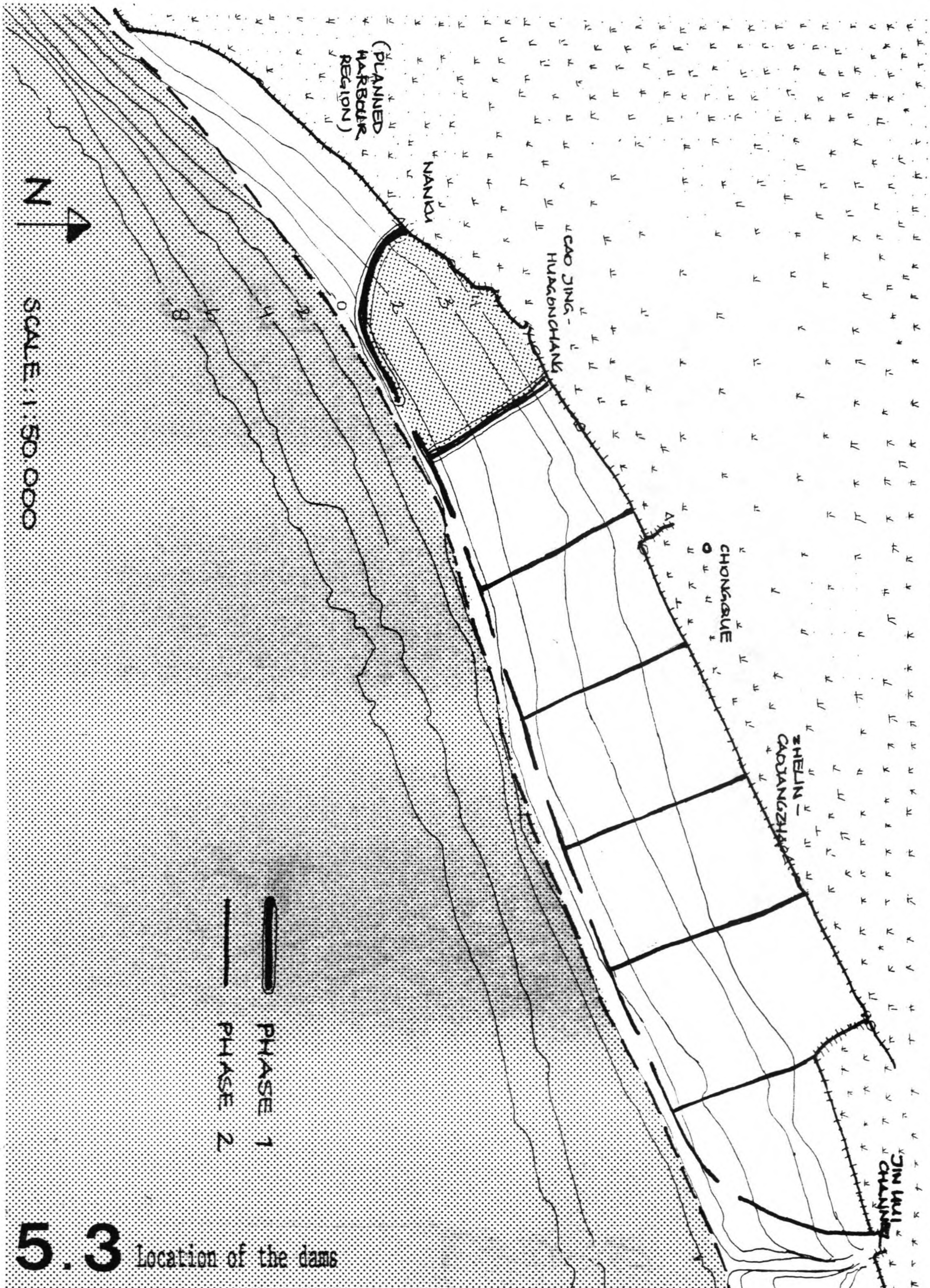
- the height of the dikes is 3.50 m (at a bottom-level of +1 m), the top of the dikes should be situated at a level of +4.50 m (Wusong);

- the expected sedimentation inside the fields is in the order of 70 à 80% of the total storage-quantity, thus a rise of the bottom-level of 1.5 m during the first year (see LAY-OUT part I, lit. (12)).

Some additional remarks:

- in order to improve the streampattern through the opening, it would be advisable to construct a threshold in the opening, of which the height is increased during the lifetime of the construction, together with the rise of the bottom-level of the basins;

- construction of the dikes should start with the cross-dams at the higher parts of the beach; the longitudinal dike however is vital to construct effective reclamation-basins. The construction of the longitudinal dike should therefore follow as soon as possible on the construction of the cross-dams.



5.3 Location of the dams

5.2 Design-criteria for construction

Now the lay-out of the dikes is known (see Fig. 5.3) and the height of the dike, the design-criteria (i.e. the design-wave, the design-current etc.) can be determined.

For the construction a distinction can be made between "normal" conditions, during which the system should be effective and the forces on the construction are low, and the extreme conditions which determine the necessary stability of the construction against loadings.

The extreme conditions give rise to a number of design-criteria:

- DESIGN-LEVEL : the maximum water-level which the construction should be able to resist;
- DESIGN-WAVE : the maximum wave which the construction should be able to resist;
- DESIGN-CURRENT : the maximum current which the construction should be able to resist.

These design-circumstances can occur at the same time, so the worst combination is determining the necessary stability (i.e. weight and size) of the construction.

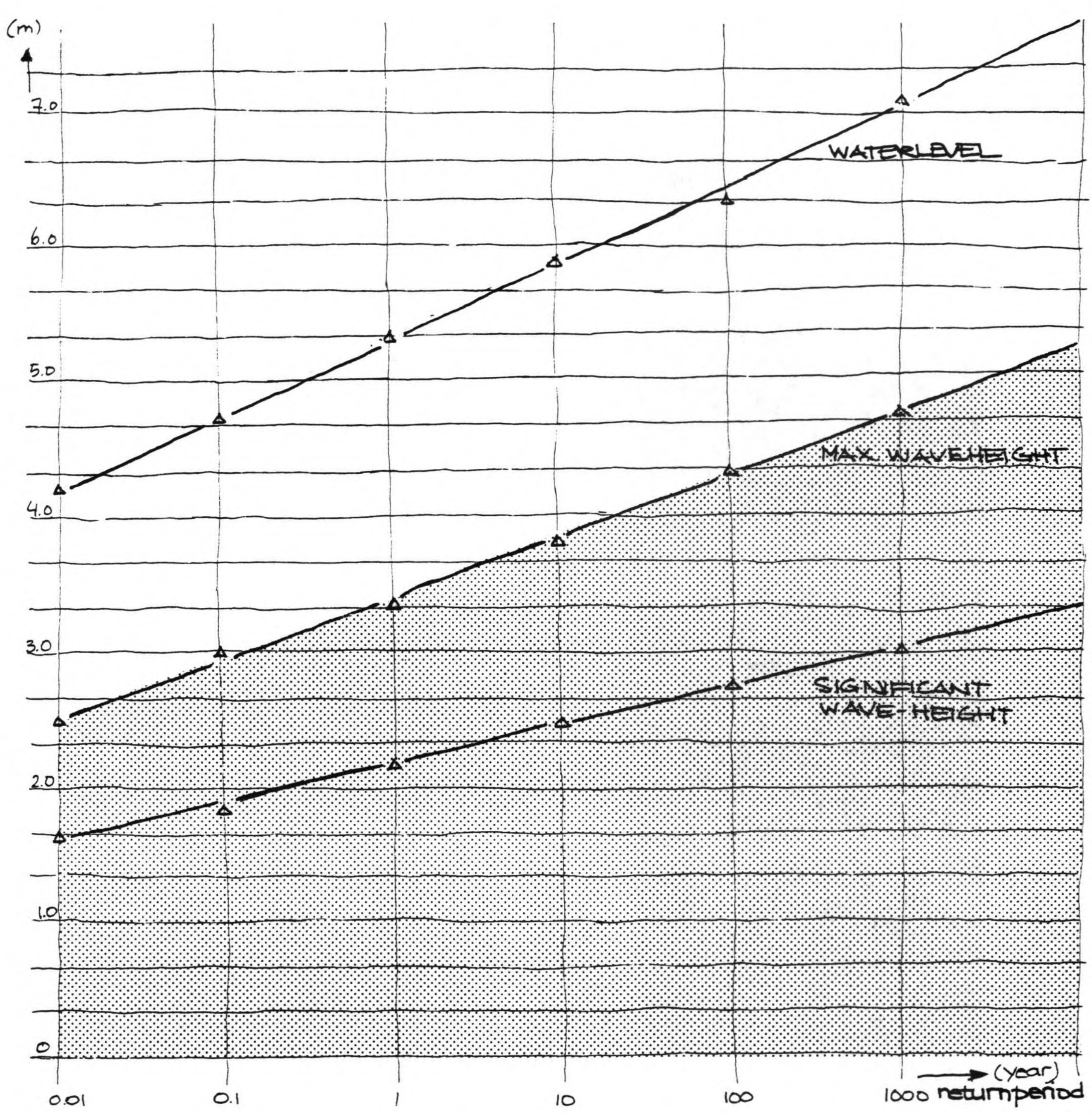
DESIGN-LEVEL (see Fig. 5.4)

In par. 2.2 the distribution of extreme water-levels has been calculated; the estimated lifetime of the construction is 5 years;

T_{return} = 5 years —> h = 5.70 m
T_{return} = 10 years —> h = 5.90 m

The criterion for the construction is chosen in such a way that it has to survive the once-in-ten-years-storm;

h = 5.90 m.



5.4

Distribution of extreme water-level and extreme wave-height at the construction-site

DESIGN-WAVE

In par. 3.4 the wave-climate at Cao Jing district has been calculated. The significant wave-height and the maximum wave-height are directly proportional to the waterdepth in extreme cases.
Extreme conditions will occur during extreme strong wind (typhoon-conditions), on such the maximum wave will occur in combination with an extreme water-level.

T_{return} = 5 years —> H_s = 0.5 d = 2.35 m
T_{return} = 10 years —> H_s = 0.5 d = 2.45 m

T_{return} = 5 years —> H_{max} = 0.78 d = 3.65 m
T_{return} = 10 years —> H_{max} = 0.78 d = 3.82 m

Since the criterion for the the construction is a required lifetime of 5 years and it has to survive the once-in-ten-years-storm;

H_s = 2.45 m
H_{max} = 3.82 m

DESIGN-CURRENT

The current-velocity along the planned dike-location is dependent on the tidal motion. During the extreme circumstances, the water-level is high, thus the current velocities will be moderate (maximum current velocities occur a tidal level around the mean water-level).
Therefore, as a design-current is chosen:

$\bar{U}_{max}$ = 1.0 m/s.

Notations

B	=	1. opening-width	(m)
		2. width of dike-top perpendicular to wave-crests	(m)
B_o	=	width of dike-top (cross-section)	(m)
C	=	1. Chézy roughness parameter	(√m/s)
		2. transmission parameter	(-)
C'	=	Chézy value with respect to grains	(√m/s)
D	=	diameter	(m)
D_{50}	=	average grain diameter	(m)
D_{90}	=	90%-grain diameter	(m)
D_*	=	particle-size parameter	(-)
E	=	from East direction	(-)
F	=	1. fetch-length	(m)
		2. suspension-parameter	(-)
		3. relative freeboard	(m)
H	=	wave-height	(m)
H_i	=	incoming wave-height	(m)
H_{max}	=	maximum wave-height	(m)
H_s	=	significant wave-height	(m)
H_t	=	transmitted wave-height	(m)
HW	=	high-water-level	(m)
$\overline{H}$	=	average wave-height	(m)
H_{10}	=	10%-exceedance wave-height	(m)
H_{50}	=	50%-exceedance wave-height	(m)
K_r	=	refraction wave-height coefficient	(-)
K_s	=	shoaling wave-height coefficient	(-)
K_T	=	transmission wave-height coefficient	(-)
K'	=	diffraction wave-height coefficient	(-)
K_1	=	tidal component (once a day)	(-)

L	= 1. wave-length	(m)
	2. length of the fields	(m)
L_o	= deep-water wave-length	(m)
LW	= low-water-level	(m)
M_2	= tidal component (moon: twice a day)	(-)
M_4	= tidal component (moon: four times a day)	(-)
MS_4	= tidal component (moon: plus sun, four times a day)	(-)
N	= 1. number of events	(-)
	2. from North-direction	(-)
NE	= from North-East-direction	(-)
NW	= from North-West-direction	(-)
O_1	= tidal component (once a day)	(-)
O_2	= tidal component (once a day)	(-)
R	= wave-runup, perpendicular to wave-crests	(m)
R_o	= wave-runup from waves perpendicular to construction	(m)
S	= 1. transport-rate	(m2/s)
	2. from South-direction	(-)
SE	= from South-East-direction	(-)
SW	= from South-West-direction	(-)
S_b	= bedload transport-rate	(m2/s)
T	= 1. wave-period	(s)
	2. transport-stage parameter	(-)
T_o	= deep-water wave-period	(s)
$\bar{T}$	= representative wave-period	(s)
U	= wind-speed	(m/s)
U_1	= 1%-exceedance wind-speed	(m/s)
U_{10}	= 10%-exceedance wind-speed	(m/s)
$\bar{U}$	= average wind-speed	(m/s)

W	= from West-direction	(-)
Z	= suspension number	(-)
Z'	= modified suspension number	(-)

a	= 1. constant	(-)
	2. reference level (concentration)	(m)
a_b	= maximum displacement wave	(m)
b	= 1. constant	(-)
	2. width of channel of stream	(m)
c	= 1. constant	(-)
	2. concentration	(-)
	3. transmission parameter	(-)
c_a	= reference concentration at the bottom	(-)
d	= water-depth	(m)
f_w	= friction coefficient with respect to the waves	(-)
g	= acceleration of gravity	(m/s^2)
h	= water-level	(m)
h_{10}	= 10%-exceedance water-level	(m)
h_{max}	= maximum water-level	(m)
k	= wave-number = $2\pi/L$	(rad/m)
p	= chance of occurrence	(-)
r	= roughness	(m)
u	= horizontal current velocity	(m/s)
$\bar{u}$	= average current velocity	(m/s)
$\hat{u}_b$	= maximum orbital wave-velocity at the bottom	(m/s)
u_*	= shear-stress velocity (at the bottom)	(m/s)
w_s	= particle fall velocity	(m/s)
x	= horizontal co-ordinate	(-)
y	= vertical co-ordinate	(-)
z	= vertical co-ordinate	(-)

Δ	=	relative density = $(\rho s-\rho)/\rho$	(-)
θ	=	slope of construction-side	(rad)
α	=	angle between wave-crest and coast-line	(rad)
α_0	=	angle at deep-water between wave-crest and coast-line	(rad)
β	=	1. angle between wave-crest and construction-axis	(rad)
		2. diffusion parameter sediment-water mixture	(-)
ν	=	kinematic viscosity of water	(m2/s)
κ	=	constant of Von Karman = 0.4	(-)
ξ	=	breaker-index	(-)
ρ	=	density of water	(kg/m3)
ρ_s	=	density of sediments	(kg/m3)
τ	=	shear-stress	(N/m2)
τ_c	=	shear-stress due to currents	(N/m2)
τ'_c	=	modified shear-stress due to currents	(N/m2)
τ_w	=	shear-stress due to waves	(N/m2)
τ_w	=	maximum shear-stress due to waves	(N/m2)
φ	=	modification parameter suspension number	(-)
ω	=	wave-frequency = $2\ \pi/T$	(rad/s)

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PERIOD: (OVER-ALL) 1963-1971

JANUARY

TABLE 18

AREA 0004 SHANGHAI
30.6N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	N							NE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	.0	1.6	.0	.0	.0	.0	1.6
1-2	.0	5.1	2.7	.0	.0	.0	7.8	.0	11.8	2.0	.0	.0	.0	13.7
3-4	.0	8.6	9.8	.0	.0	.0	18.4	.0	5.1	6.7	.0	.0	.0	11.8
5-6	.0	.0	1.6	1.6	.0	.0	3.1	.0	.0	7.8	.0	.0	.0	7.8
7	.0	.0	4.3	1.6	.0	.0	5.9	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	1.2	.0	.0	1.2	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	13.7	18.4	4.3	.0	.0	36.5	.0	18.4	16.5	.0	.0	.0	34.9

	E							SE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.6	.0	.0	.0	.0	.0	1.6	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0	.0	1.6	.0	.0	.0	.0	1.6
3-4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.6	.0	.0	.0	.0	.0	1.6	.0	1.6	.0	.0	.0	.0	1.6

PERIOD: (OVER-ALL) 1963-1971

JANUARY

TABLE 18

AREA 0004 SHANGHAI
30.6N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	S							SW						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.6	.0	.0	.0	.0	1.6	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0	.0	.0	.0	.4
5-6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.6	.0	.0	.0	.0	1.6	.0	.4	.0	.0	.0	.0	.4

	W							NW						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	1.6	.0	1.6	.0	.0	.0	3.1
1-2	.0	.0	.0	.0	.0	.0	.0	.0	.4	3.1	.0	.0	.0	3.5
3-4	.0	1.2	1.2	.0	.0	.0	2.4	.0	3.5	4.3	1.6	.0	.0	9.4
5-6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	1.6	.0	.0	2.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0	.0	.4
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.6	.0	.0	1.6
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.2	1.2	.0	.0	.0	2.4	1.6	3.9	9.4	5.1	.0	.0	20.0

JANUARY

PERIOD: (OVER-ALL) 1963-1971

AREA 0004 SHANGHAI
30.6N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	4.7	1.6	1.6	.0	.0	.0	7.8	
1-2	.0	20.3	7.8	.0	.0	.0	28.1	
3-4	.0	18.8	21.9	1.6	.0	.0	42.2	
5-6	.0	.0	9.4	1.6	.0	.0	10.9	
7	.0	.0	4.7	3.1	.0	.0	7.8	
8-9	.0	.0	.0	1.6	.0	.0	1.6	
10-11	.0	.0	.0	.0	.0	.0	.0	
12	.0	.0	.0	1.6	.0	.0	1.6	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	4.7	40.6	45.3	9.4	.0	.0	100.0	64

PERIOD: (OVER-ALL) 1949-1971

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	ME H.
<6	1.0	18.2	17.2	3.0	1.0	1.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	42	
6-7	.0	2.0	9.1	8.1	5.1	3.0	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	29	
8-9	.0	.0	.0	3.0	3.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	7	
10-11	.0	.0	.0	1.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2	
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	3.0	6.1	5.1	1.0	3.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	19	
TOTAL	4	26	31	16	12	5	4	1	0	0	0	0	0	0	0	0	0	0	0	99	
PCT	4.0	26.3	31.3	16.2	12.1	5.1	4.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

FEBRUARY

PERIOD: (OVER-ALL) 1963-1971

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	N							NE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.8	.0	.0	.0	.0	.0	1.8	.0	1.8	.0	.0	.0	.0	1.8
1-2	.0	9.7	1.8	.0	.0	.0	11.5	.0	2.2	2.2	.0	.0	.0	4.4
3-4	.0	.0	21.6	.0	.0	.0	21.6	.0	1.8	7.5	.0	.0	.0	9.3
5-6	.0	.0	3.1	3.5	.0	.0	6.6	.0	.0	5.7	.0	.0	.0	5.7
7	.0	.0	6.6	8.8	.0	.0	15.4	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
0-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PCT	1.8	9.7	33.0	12.3	.0	.0	56.8	.0	5.7	15.4	.0	.0	.0	21.1

	E							SE						
IGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
1	.0	.0	.0	.0	.0	.0	.0	3.5	1.8	.0	.0	.0	.0	5.3
-2	.0	1.8	1.3	.0	.0	.0	3.1	.0	.0	1.8	.0	.0	.0	1.8
1-4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PCT	.0	1.8	1.3	.0	.0	.0	3.1	3.5	1.8	1.8	.0	.0	.0	7.0

PERIOD: (OVER-ALL) 1963-1971

FEBRUARY

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.3	.0	.0	.0	.0	1.3
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.3	.0	.0	.0	.0	1.3

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.4	.0	.0	.0	.0	.4
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.4	.0	.0	.0	.0	.4

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.3	.0	.0	.0	.0	1.3
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.3	.0	.0	.0	.0	1.3

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.9	1.8	.0	.0	.0	2.6
3-4	.0	.0	4.4	.0	.0	.0	4.4
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.4	.0	.0	.0	.4
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.9	6.6	.0	.0	.0	7.5

PERIOD: (OVER-ALL) 1963-1971

AREA 0004 SHANGHAI
30.5N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	8.6	3.4	.0	.0	.0	.0	12.1	
1-2	.0	17.2	8.6	.0	.0	.0	25.9	
3-4	.0	1.7	32.8	.0	.0	.0	34.5	
5-6	.0	.0	8.6	3.4	.0	.0	12.1	
7	.0	.0	6.9	8.6	.0	.0	15.5	
8-9	.0	.0	.0	.0	.0	.0	.0	
10-11	.0	.0	.0	.0	.0	.0	.0	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	58
TOT PCT	8.6	22.4	56.9	12.1	.0	.0	100.0	

PERIOD: (OVER-ALL) 1949-1971

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	6.2	6.2	17.3	8.6	7.4	1.2	.0	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	39	4
6-7	.0	2.5	7.4	8.6	7.4	1.2	1.2	.0	.0	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	24	6
8-9	.0	1.2	1.2	1.2	2.5	1.2	2.5	.0	.0	.0	.0	.0	.C	.0	.0	.0	.0	.0	.0	8	7
10-11	.0	.0	.0	.0	.0	1.2	.0	.0	.0	2.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	3	13
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	3.7	.0	3.7	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	7	2
TOTAL	8	8	24	16	14	4	3	1	0	3	0	0	0	0	0	0	0	0	0	81	5
PCT	9.9	9.9	29.6	19.8	17.3	4.9	3.7	1.2	.0	3.7	.0	.0	.C	.0	.0	.0	.0	.0	.0	100.0	

PERIODI (OVER-ALL) 1963-1971

MARCH

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

N

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.4	.0	.0	.0	.0	1.4
1-2	1.4	4.2	2.5	.0	.0	.0	8.1
3-4	.0	3.9	9.2	.0	.0	.0	13.1
5-6	.0	.0	4.2	.0	.0	.0	4.2
7	.0	.0	3.5	.0	.0	.0	3.5
8-9	.0	.0	.0	1.4	.0	.0	1.4
0-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
3-16	.0	.0	.0	.0	.0	.0	.0
7-19	.0	.0	.0	.0	.0	.0	.0
)-22	.0	.0	.0	.0	.0	.0	.0
-25	.0	.0	.0	.0	.0	.0	.0
-32	.0	.0	.0	.0	.0	.0	.0
-40	.0	.0	.0	.0	.0	.0	.0
-48	.0	.0	.0	.0	.0	.0	.0
-60	.0	.0	.0	.0	.0	.0	.0
-70	.0	.0	.0	.0	.0	.0	.0
-86	.0	.0	.0	.0	.0	.0	.0
7+	.0	.0	.0	.0	.0	.0	.0
PCT	1.4	9.5	19.4	1.4	.0	.0	31.8

NE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	2.8	.0	1.4	.0	.0	.0	4.2
1-2	1.4	13.1	1.8	.0	.0	.0	16.3
3-4	.0	.7	4.9	.0	.0	.0	5.7
5-6	.0	.0	1.4	1.4	.0	.0	2.8
7	.0	.0	1.8	.0	.0	.0	1.8
8-9	.0	.0	.0	.0	.0	.0	.0
0-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
3-16	.0	.0	.0	.0	.0	.0	.0
7-19	.0	.0	.0	.0	.0	.0	.0
)-22	.0	.0	.0	.0	.0	.0	.0
-25	.0	.0	.0	.0	.0	.0	.0
-32	.0	.0	.0	.0	.0	.0	.0
-40	.0	.0	.0	.0	.0	.0	.0
-48	.0	.0	.0	.0	.0	.0	.0
-60	.0	.0	.0	.0	.0	.0	.0
-70	.0	.0	.0	.0	.0	.0	.0
-86	.0	.0	.0	.0	.0	.0	.0
7+	.0	.0	.0	.0	.0	.0	.0
PCT	4.2	13.8	11.3	1.4	.0	.0	30.7

E

GT	1-3	4-10	11-21	22-33	34-47	48+	PCT
1	.0	4.2	.0	.0	.0	.0	4.2
-2	.0	2.5	1.4	.0	.0	.0	3.9
-4	.0	1.1	.0	.0	.0	.0	1.1
-6	.0	1.4	.0	.0	.0	.0	1.4
7	.0	.0	.0	.0	.0	.0	.0
-9	.0	.0	.0	.0	.0	.0	.0
-11	.0	.0	.0	.0	.0	.0	.0
2	.0	.0	.0	.0	.0	.0	.0
-16	.0	.0	.0	.0	.0	.0	.0
-19	.0	.0	.0	.0	.0	.0	.0
-22	.0	.0	.0	.0	.0	.0	.0
-25	.0	.0	.0	.0	.0	.0	.0
-32	.0	.0	.0	.0	.0	.0	.0
-40	.0	.0	.0	.0	.0	.0	.0
-48	.0	.0	.0	.0	.0	.0	.0
-60	.0	.0	.0	.0	.0	.0	.0
-70	.0	.0	.0	.0	.0	.0	.0
-86	.0	.0	.0	.0	.0	.0	.0
+	.0	.0	.0	.0	.0	.0	.0
PCT	.0	9.2	1.4	.0	.0	.0	10.6

SE

GT	1-3	4-10	11-21	22-33	34-47	48+	PCT
1	.0	.4	.0	.0	.0	.0	.4
-2	.0	1.4	.0	.0	.0	.0	1.4
-4	.0	1.4	.0	.0	.0	.0	1.4
-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
-9	.0	.0	.0	.0	.0	.0	.0
-11	.0	.0	.0	.0	.0	.0	.0
2	.0	.0	.0	.0	.0	.0	.0
-16	.0	.0	.0	.0	.0	.0	.0
-19	.0	.0	.0	.0	.0	.0	.0
-22	.0	.0	.0	.0	.0	.0	.0
-25	.0	.0	.0	.0	.0	.0	.0
-32	.0	.0	.0	.0	.0	.0	.0
-40	.0	.0	.0	.0	.0	.0	.0
-48	.0	.0	.0	.0	.0	.0	.0
-60	.0	.0	.0	.0	.0	.0	.0
-70	.0	.0	.0	.0	.0	.0	.0
-86	.0	.0	.0	.0	.0	.0	.0
+	.0	.0	.0	.0	.0	.0	.0
PCT	.0	3.2	.0	.0	.0	.0	3.2

PERIOD: (OVER-ALL) 1963-1971

MARCH

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	2.5	.0	.0	.0	.0	2.5
1-2	.0	4.2	1.4	.0	.0	.0	5.7
3-4	.0	1.4	.0	.0	.0	.0	1.4
5-6	.0	.0	1.4	.0	.0	.0	1.4
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	8.1	2.8	.0	.0	.0	11.0

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.4	.0	.0	.0	.0	1.4
3-4	.0	1.4	.0	.0	.0	.0	1.4
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	2.8	.0	.0	.0	.0	2.8

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	2.5	.0	.0	.0	2.5
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	2.5	.0	.0	.0	2.5

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.4	.0	.0	.0	.0	1.4
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	1.4	1.4	.0	.0	.0	2.8
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	2.1	.0	.0	.0	2.1
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	2.8	3.5	.0	.0	.0	6.4

PERIOD: (OVER-ALL) 1963-1971

AREA 0004 SHANGHAI
30.5N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	4.2	9.9	1.4	.0	.0	.0	15.5	
1-2	2.8	26.8	7.0	.0	.0	.0	36.6	
3-4	.0	11.3	15.5	.0	.0	.0	26.8	
5-6	.0	1.4	7.0	1.4	.0	.0	9.9	
7	.0	.0	9.9	.0	.0	.0	9.9	
8-9	.0	.0	.0	1.4	.0	.0	1.4	
10-11	.0	.0	.0	.0	.0	.0	.0	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	71
TOT PCT	7.0	49.3	40.8	2.8	.0	.0	100.0	

PERIOD: (OVER-ALL) 1949-1971

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	8.1	13.1	15.2	10.1	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	49	3
6-7	.0	4.0	7.1	6.1	3.0	6.1	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27	5
8-9	.0	.0	2.0	2.0	3.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	8	6
10-11	.0	.0	.0	1.0	.0	1.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3	8
12-13	.0	.0	1.0	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2	6
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	6.1	3.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10	1
TOTAL	14	20	25	20	9	9	1	1	0	0	0	0	0	0	0	0	0	0	0	99	4
PCT	14.1	20.2	25.3	20.2	9.1	9.1	1.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PERIOD: (OVER-ALL) 1963-1970

APRIL

TABLE 18

AREA 0004 SHANGHAI
30.6N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	N							NE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	1.5	3.0	.0	.0	.0	.0	4.4
1-2	.0	8.5	2.6	.0	.0	.0	11.1	1.5	3.3	4.8	.0	.0	.0	9.6
3-4	.0	1.5	8.1	.0	.0	.0	9.6	.0	1.5	6.3	.0	.0	.0	7.8
5-6	.0	1.5	6.7	.0	.0	.0	8.1	.0	.0	3.3	.0	.0	.0	3.3
7	.0	.0	2.6	.0	.0	.0	2.6	.0	.0	.4	.0	.0	.0	.4
8-9	.0	.0	.0	1.5	.0	.0	1.5	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
0-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
T PCT	.0	11.5	20.0	1.5	.0	.0	33.0	3.0	7.8	14.8	.0	.0	.0	25.6

	E							SE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	.0	3.0	.0	.0	.0	.0	3.0
1-2	.0	1.1	.0	.0	.0	.0	1.1	.0	6.3	3.3	.0	.0	.0	9.6
3-4	.0	1.5	.0	.0	.0	.0	1.5	.0	3.0	1.5	.0	.0	.0	4.4
5-6	.0	.0	.0	1.5	.0	.0	1.5	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0	.0	.0	.4
0-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
0-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
IT PCT	.0	2.6	.0	1.5	.0	.0	4.1	.0	12.2	5.2	.0	.0	.0	17.4

PERIOD: (OVER-ALL) 1963-1970

APRIL

TABLE 18

AREA 0004 SHANGHAI
30.6N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	S							SW						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-2	.0	4.4	1.1	.0	.0	.0	5.6	.0	1.5	.0	.0	.0	.0	1.5
3-4	.0	1.1	1.1	.0	.0	.0	2.2	.0	1.9	1.9	.0	.0	.0	3.7
5-6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	1.1	.0	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	5.6	3.3	.0	.0	.C	8.9	.0	3.3	1.9	.0	.0	.0	5.2

	W							NW						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	.0	1.5	.0	.0	.0	.0	1.5
1-2	.0	.0	.0	.0	.0	.0	.0	.0	1.5	.0	.0	.0	.0	1.5
3-4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0	.0	.0	.4
5-6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0	.0	.0	.4
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	.0	.0	.0	.0	.0	.0	3.0	.7	.0	.0	.0	3.7

PERIOD: (OVER-ALL) 1963-1970

AREA 0004 SHANGHAI
30.6N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	7.1	7.1	.0	.0	.0	.0	14.3	
1-2	1.4	25.7	11.4	.0	.0	.0	38.6	
3-4	.0	10.0	18.6	.0	.0	.0	28.6	
5-6	.0	1.4	10.0	1.4	.0	.0	12.9	
7	.0	.0	2.9	.0	.0	.0	2.9	
8-9	.0	.0	1.4	1.4	.0	.0	2.9	
10-11	.0	.0	.0	.0	.0	.0	.0	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	8.6	44.3	44.3	2.9	.0	.0	100.0	70

PERIOD: (OVER-ALL) 1949-1970

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	2.0	10.9	17.8	5.9	1.0	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	41	3
6-7	.0	1.0	11.9	3.0	5.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	22	4
8-9	.0	.0	.0	3.0	5.9	2.0	2.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	14	8
10-11	.0	.0	.0	.0	1.0	1.0	.0	.0	.0	.0	.0	.0	.C	.0	.0	.0	.0	.0	.0	2	8
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	10.9	3.0	3.0	2.0	2.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	22	2
TOTAL	13	15	33	14	15	7	3	0	1	0	0	0	0	0	0	0	0	0	0	101	4
PCT	12.9	14.9	32.7	13.9	14.9	6.9	3.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PERIOD: (OVER-ALL) 1963-1971

MAY

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

N

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	2.5	.0	.0	.0	.0	.0	2.5
1-2	.0	.9	.9	.0	.0	.0	1.9
3-4	.0	.0	5.3	.0	.0	.0	5.3
5-6	.0	.0	1.9	.0	.0	.0	1.9
7	.0	.0	.0	3.4	.0	.0	3.4
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	2.5	.9	8.0	3.4	.0	.0	14.9

NE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	4.0	2.8	.0	.0	.0	6.8
3-4	.0	.3	3.4	.0	.0	.0	3.7
5-6	.0	.0	1.2	.0	.0	.0	1.2
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	4.3	7.4	.0	.0	.0	11.8

E

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.2	.0	.0	.0	.0	1.2
1-2	.0	5.9	5.0	.0	.0	.0	10.8
3-4	.0	2.2	3.7	.0	.0	.0	5.9
5-6	.0	.0	1.2	.0	.0	.0	1.2
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	9.3	9.9	.0	.0	.0	19.2

SE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	2.5	.0	.0	.0	.0	2.5
1-2	.0	10.8	.0	.0	.0	.0	10.8
3-4	.0	2.5	1.2	.0	.0	.0	3.7
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	15.8	1.2	.0	.0	.0	17.0

PERIOD: (OVER-ALL) 1963-1971

MAY

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	5.6	1.2	.0	.0	.0	6.8
3-4	.0	3.7	.0	.0	.0	.0	3.7
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	9.3	1.2	.0	.0	.0	10.5

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	2.5	.0	.0	.0	.0	2.5
1-2	.0	5.0	.0	.0	.0	.0	5.0
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	2.5	.0	.0	.0	2.5
7	.0	.0	.0	1.2	.0	.0	1.2
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	7.4	2.5	1.2	.0	.0	11.1

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.2	.0	.0	.0	.0	.0	1.2
1-2	.0	.0	2.5	.0	.0	.0	2.5
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.2	.0	2.5	.0	.0	.0	3.7

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.2	.0	.0	.0	.0	.0	1.2
1-2	.0	1.2	1.2	.0	.0	.0	2.5
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.6	1.2	.0	.0	1.9
7	.0	.0	1.2	.3	.0	.0	1.5
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.2	1.2	3.1	1.5	.0	.0	7.1

PERIOD: (OVER-ALL) 1963-1971

AREA 0004 SHANGHAI
30.5N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	11.0	6.1	.0	.0	.0	.0	17.1	
1-2	.0	32.9	13.4	.0	.0	.0	46.3	
3-4	.0	8.5	13.4	.0	.0	.0	22.0	
5-6	.0	.0	7.3	1.2	.0	.0	8.5	
7	.0	.0	1.2	4.9	.0	.0	6.1	
8-9	.0	.0	.0	.0	.0	.0	.0	
10-11	.0	.0	.0	.0	.0	.0	.0	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	11.0	47.6	35.4	6.1	.0	.0	100.0	82

PERIOD: (OVER-ALL) 1949-1971

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-22	33-40	41-48	49-60	61-70	71-86	87+	TOTAL
<6	1.8	22.0	19.3	5.5	.9	1.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	56
6-7	.0	1.8	6.4	4.6	1.8	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17
8-9	.0	.9	.0	3.7	4.6	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	11
10-11	.0	.0	.0	.9	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
12-13	.0	.0	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
INDET	6.4	4.6	4.6	3.7	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	22
TOTAL	9	32	33	21	9	4	1	0	0	0	0	0	0	0	0	0	0	0	0	109
PCT	8.3	29.4	30.3	19.3	8.3	3.7	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0

PERIOD: (OVER-ALL) 1963-1971

JUNE

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.2E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

N

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.0	.0	.0	.0	.0	.0	1.0
1-2	.0	1.3	1.0	.0	.0	.0	2.3
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	1.3	1.0	.0	.0	2.3
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.0	1.3	2.3	1.0	.0	.0	5.6

NE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.3	.0	.0	.0	.0	.0	.3
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	1.3	2.6	.0	.0	.0	3.9
5-6	.0	.0	.0	2.9	.0	.0	2.9
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	1.3	.0	.0	.0	1.3
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.3	1.3	3.9	2.9	.0	.0	8.5

E

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	3.3	.0	.0	.0	.0	3.3
1-2	.0	7.2	.0	.0	.0	.0	7.2
3-4	.0	2.6	.0	.0	.0	.0	2.6
5-6	.0	.0	1.3	.0	.0	.0	1.3
7	.0	.0	1.3	.0	.0	.0	1.3
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	13.1	2.6	.0	.0	.0	15.7

SE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.3	.7	.0	.0	.0	.0	2.0
1-2	.0	12.1	.3	.0	.0	.0	12.4
3-4	.0	2.3	1.6	.0	.0	.0	3.9
5-6	.0	.0	.C	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.C	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.3	15.0	2.C	.0	.0	.0	18.3

PERIOD: (OVER-ALL) 1963-1971

JUNE

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.2E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	13.4	1.0	.0	.0	.0	14.4
3-4	.0	3.9	4.6	1.0	.0	.0	9.5
5-6	.0	.0	1.0	.0	.0	.0	1.0
7	.0	.0	2.0	.0	.0	.0	2.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	17.3	8.5	1.0	.0	.0	26.8

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.3	.0	.0	.0	.0	1.3
1-2	.0	3.9	2.6	.0	.0	.0	6.5
3-4	.0	.3	1.6	.3	.0	.0	2.3
5-6	.0	.0	.3	.0	.0	.0	.3
7	.0	.0	.7	.0	.0	.0	.7
8-9	.0	.0	1.3	.0	.0	.0	1.3
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	5.6	6.5	.3	.0	.0	12.4

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	2.6	.0	.0	.0	.0	2.6
1-2	.0	.0	1.3	.0	.0	.0	1.3
3-4	.0	1.0	1.3	.0	.0	.0	2.3
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	3.6	2.6	.0	.0	.0	6.2

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.3	.0	.0	.0	.3
3-4	.0	.3	1.3	.0	.0	.0	1.6
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	2.6	.0	.0	.0	2.6
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.3	4.2	.0	.0	.0	4.6

PERIOD: (OVER-ALL) 1963-1971

AREA 0004 SHANGHAI
30.5N 122.2E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	6.4	7.7	.0	.0	.0	.0	14.1	
1-2	.0	37.2	6.4	.0	.0	.0	43.6	
3-4	.0	11.5	12.8	1.3	.0	.0	25.6	
5-6	.0	.0	3.8	3.8	.0	.0	7.7	
7	.0	.0	6.4	.0	.0	.0	6.4	
8-9	.0	.0	2.6	.0	.0	.0	2.6	
10-11	.0	.0	.0	.0	.0	.0	.0	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	6.4	56.4	32.1	5.1	.0	.0	100.0	78

PERIOD: (OVER-ALL) 1949-1971

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTA[illegible]
<6	2.2	21.7	23.9	3.3	3.3	0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5[illegible]
6-7	.0	1.1	7.6	9.8	5.4	3.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2[illegible]
8-9	.0	.0	.0	1.1	3.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	[illegible]
10-11	.0	1.1	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	[illegible]
12-13	.0	.0	.0	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	[illegible]
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	[illegible]
INDET	2.2	2.2	4.3	1.1	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	[illegible]
TOTAL	4	24	33	15	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	9[illegible]
PCT	4.3	26.1	35.9	16.3	13.0	4.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.[illegible]

PERIOD: (OVER-ALL) 1963-1968

JULY

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

wave

N							
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	.0	.0	.0	.0	.0

NE							
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.0	.0	.0	.0	.0	1.0
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.0	.0	.0	.0	.0	1.0

E							
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.0	.0	.0	.0	.0	1.0
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.0	.0	.0	.0	.0	1.0

SE							
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.0	.0	.0	.0	.0	1.0
1-2	2.0	2.2	3.7	.0	.0	.0	7.9
3-4	.0	.5	3.0	.0	.0	.0	3.4
5-6	.0	.2	.2	.0	.0	.0	.5
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	1.0	.0	.0	.0	1.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	2.0	3.9	7.9	.0	.0	.0	13.8

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	S							SW						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.7	1.0	.0	.0	.0	2.7	.0	1.2	.0	.0	.0	.0	1.2
1-2	.0	10.1	11.1	.0	.0	.0	21.2	.0	2.5	5.2	.0	.0	.0	7.6
3-4	.0	4.9	18.5	.0	.0	.0	23.4	.0	.5	4.2	.0	.0	.0	4.7
5-6	.0	1.7	13.1	2.0	.0	.0	16.7	.0	.0	2.5	.0	.0	.0	2.5
7	.0	.0	2.0	.0	.0	.0	2.0	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	18.5	45.6	2.0	.0	.0	66.0	.0	4.2	11.8	.0	.0	.0	16.0

	W							NW						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.7	.0	.0	.0	.7	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	.7	.0	.0	.0	.7	.0	.0	.0	.0	.0	.0	.0

PERIOD: (OVER-ALL) 1963-1968

AREA 0004 SHANGHAI
30.5N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	2.0	3.9	1.0	.0	.0	.0	6.9	
1-2	2.0	16.7	20.6	.0	.0	.0	39.2	
3-4	.0	5.9	25.5	.0	.0	.0	31.4	
5-6	.0	2.0	15.7	2.0	.0	.0	19.6	
7	.0	.0	2.0	.0	.0	.0	2.0	
8-9	.0	.0	.0	.0	.0	.0	.0	
10-11	.0	.0	1.0	.0	.0	.0	1.0	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	3.9	28.4	65.7	2.0	.0	.0	100.0	102

PERIOD: (OVER-ALL) 1950-1968

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	.9	19.1	15.7	6.1	2.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	51	3
6-7	.0	1.7	7.0	10.4	7.0	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	32	5
8-9	.0	.9	.9	2.6	4.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10	6
10-11	.0	.0	.0	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2	6
12-13	.0	.0	.0	.9	.0	.0	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3	9
>13	.0	.0	.0	.0	.0	.0	.0	.0	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	2	16
INDET	2.6	5.2	4.3	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	15	2
TOTAL	4	31	32	24	18	1	2	1	1	1	0	0	0	0	0	0	0	0	0	115	4
PCT	3.5	27.0	27.8	20.9	15.7	.9	1.7	.9	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PERIOD: (OVER-ALL) 1963-1970

AUGUST

TABLE 18

AREA 0004 SHANGHAI
30.4N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

N

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	3.2	.0	.0	.0	.0	3.2
3-4	.0	.0	1.3	1.3	.0	.0	2.6
5-6	.0	.0	2.6	1.0	.0	.0	3.6
7	.0	.0	1.3	1.0	.0	.0	2.3
8-9	.0	.0	.0	1.0	.0	.0	1.0
10-11	.0	.0	.0	2.3	.0	.0	2.3
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	3.2	5.2	6.5	.0	.0	14.9

NE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.3	.0	.0	.0	.0	1.3
1-2	.0	1.9	.0	.0	.0	.0	1.9
3-4	.0	1.3	.0	.0	.0	.0	1.3
5-6	.0	.0	.0	1.3	.0	.0	1.3
7	.0	.0	.0	.3	.0	.0	.3
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	4.5	.0	1.6	.0	.0	6.1

E

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	1.0	.0	.0	.0	1.0
1-2	.0	1.9	.0	.0	.0	.0	1.9
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	2.6	.0	.0	.0	2.6
7	.0	.0	1.0	.0	.0	.0	1.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.9	4.5	.0	.0	.0	6.5

SE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.3	.0	.0	.0	.3
1-2	.0	7.4	1.3	.0	.0	.0	8.7
3-4	.0	2.6	1.3	.0	.0	.0	3.9
5-6	.0	.0	1.3	.0	.0	.0	1.3
7	.0	.0	.3	1.3	.0	.0	1.6
8-9	.0	.0	1.3	.0	.0	.0	1.3
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	10.0	5.8	1.3	.0	.0	17.2

PERIOD: (OVER-ALL) 1963-1970

AUGUST

TABLE 18

AREA 0004 SHANGHAI
30.4N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	3.6	.0	.0	.0	.0	3.6
1-2	.0	9.4	1.3	.0	.0	.0	10.7
3-4	.0	1.3	4.5	.0	.0	.0	5.8
5-6	.0	.0	3.9	.0	.0	.0	3.9
7	.0	.0	1.3	.0	.0	.0	1.3
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	14.2	11.0	.0	.0	.0	25.2

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	2.9	.0	.0	.0	.0	2.9
1-2	.0	4.9	2.6	.0	.0	.0	7.4
3-4	.0	1.3	.6	.0	.0	.0	1.9
5-6	.0	1.3	1.3	.0	.0	.0	2.6
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	10.4	4.5	.0	.0	.0	14.9

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	3.6	.0	.0	.0	.0	3.6
3-4	.0	.0	1.3	.0	.0	.0	1.3
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.C	.0
TOT PCT	.0	3.6	1.3	.0	.0	.0	4.9

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.3	1.3	.0	.0	.0	2.6
3-4	.0	1.3	2.6	.0	.0	.0	3.9
5-6	.0	.0	.0	.3	.0	.0	.3
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.3	.0	.0	.3
10-11	.0	.0	.0	.3	.0	.0	.3
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	2.6	3.9	1.0	.0	.0	7.4

PERIOD: (OVER-ALL) 1963-1970

AREA 0004 SHANGHAI
30.4N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	3.8	7.6	1.3	.0	.0	.0	12.7	
1-2	.0	32.9	6.3	.0	.0	.0	39.2	
3-4	.0	7.6	11.4	1.3	.0	.0	20.3	
5-6	1.3	1.3	11.4	2.5	.0	.0	16.5	
7	.0	.0	3.8	2.5	.0	.0	6.3	
8-9	.0	.0	1.3	1.3	.0	.0	2.5	
10-11	.0	.0	.0	2.5	.0	.0	2.5	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	5.1	49.4	35.4	10.1	.0	.0	100.0	79

PERIOD: (OVER-ALL) 1953-1970

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	ME H
<6	3.7	9.3	16.8	6.5	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	41	
6-7	.0	3.7	7.5	10.3	3.7	.9	.0	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	30	
8-9	.0	.9	3.7	3.7	.9	4.7	.9	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17	
10-11	.0	.0	.0	.9	.0	.0	1.9	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5	
12-13	.0	.0	.0	.0	.0	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1	
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	2.8	2.8	3.7	1.9	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	13	
TOTAL	7	18	34	25	6	8	4	2	3	0	0	0	0	0	0	0	0	0	0	107	
PCT	6.5	16.8	31.8	23.4	5.6	7.5	3.7	1.9	2.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PERIOD: (OVER-ALL) 1963-1969

SEPTEMBER

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

N

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.2	.0	.0	.0	.0	1.2
1-2	.9	1.8	3.1	.0	.0	.0	5.8
3-4	.0	1.2	6.2	.0	.0	.0	7.4
5-6	.0	1.2	6.8	1.2	.0	.0	9.2
7	.0	.0	3.1	1.2	.0	.0	4.3
8-9	.0	.0	1.8	3.1	.0	.0	4.9
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	1.2	.0	1.2
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.9	5.5	20.9	5.5	1.2	.0	34.2

NE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	4.9	.0	.0	.0	.0	4.9
1-2	.3	2.5	2.8	.0	.0	.0	5.5
3-4	.0	3.7	.6	.0	.0	.0	4.3
5-6	.0	.0	5.2	.0	.0	.0	5.2
7	.0	.0	1.8	.0	.0	.0	1.8
8-9	.0	.0	.6	1.5	.0	.0	2.2
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.3	11.1	11.1	1.5	.0	.0	24.0

E

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.2	1.2	.0	.0	.0	.0	2.5
1-2	1.2	2.5	.0	.0	.0	.0	3.7
3-4	.0	1.2	1.2	.0	.0	.0	2.5
5-6	.0	.0	2.2	.0	.0	.0	2.2
7	.0	.0	1.2	.0	.0	.0	1.2
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	2.5	4.9	4.6	.0	.0	.0	12.0

SE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.2	.0	.0	.0	.0	.0	1.2
1-2	.0	1.2	.0	.0	.0	.0	1.2
3-4	.0	.0	.3	.0	.0	.0	.3
5-6	.0	.0	1.5	.0	.0	.0	1.5
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	1.2	.0	.0	1.2
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.2	1.2	1.8	1.2	.0	.0	5.5

TABLE 18

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	3.4	.0	.0	.0	.0	3.4
3-4	.0	1.2	2.2	.0	.0	.0	3.4
5-6	.0	.0	2.5	.0	.0	.0	2.5
7	.0	.0	1.2	.0	.0	.0	1.2
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.9	.0	.0	.0	.9
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	4.6	6.8	.0	.0	.0	11.4

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.2	.0	.0	.0	.0	1.2
1-2	.0	.3	.0	.0	.0	.0	.3
3-4	.0	1.2	1.2	.0	.0	.0	2.5
5-6	.0	.0	1.2	.0	.0	.0	1.2
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.3	.0	.0	.0	.3
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	2.8	2.8	.0	.0	.0	5.5

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.9	.0	.0	.0	.0	.9
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.9	.0	.0	.0	.0	.9

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.9	.3	.0	.0	.0	1.2
3-4	.0	.0	.6	.0	.0	.0	.6
5-6	.0	.0	.3	.0	.0	.0	.3
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.3	.0	.0	.3
10-11	.0	.0	.0	.0	1.2	.0	1.2
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.9	1.2	.3	1.2	.0	3.7

PERIOD: (OVER-ALL) 1963-1969

AREA 0004 SHANGHAI
30.5N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	6.1	8.5	.0	.0	.0	.0	14.6	
1-2	2.4	13.4	6.1	.0	.0	.0	22.0	
3-4	.0	8.5	12.2	.0	.0	.0	20.7	
5-6	.0	1.2	19.5	1.2	.0	.0	22.0	
7	.0	.0	7.3	1.2	.0	.0	8.5	
8-9	.0	.0	2.4	6.1	.0	.0	8.5	
10-11	.0	.0	.0	.0	1.2	.0	1.2	
12	.0	.0	1.2	.0	1.2	.0	2.4	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
								82
TOT PCT	8.5	31.7	48.8	8.5	2.4	.0	100.0	

PERIOD: (OVER-ALL) 1949-1969

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEA HG
<6	4.8	11.9	11.1	11.1	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	50	
6-7	.0	2.4	1.6	10.3	4.0	1.6	.8	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27	
8-9	.0	.8	.0	2.4	4.0	2.4	1.6	1.6	.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	17	
10-11	.0	.0	.0	.0	.0	.0	1.6	1.6	.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	5	1.
12-13	.0	.0	.0	.0	.8	.8	.8	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4	
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	6.3	3.2	3.2	3.2	1.6	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	23	
TOTAL	14	23	20	34	14	7	6	6	0	2	0	0	0	0	0	0	0	0	0	126	
PCT	11.1	18.3	15.9	27.0	11.1	5.6	4.8	4.8	.0	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	N							NE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.3	.0	.0	.0	.0	1.3	.0	1.6	.0	.0	.0	.0	1.6
1-2	.0	5.7	3.2	.0	.0	.0	8.9	.0	4.4	1.6	.0	.0	.0	6.0
3-4	.0	7.3	6.7	.0	.0	.0	14.0	.0	2.5	3.5	.0	.0	.0	6.0
5-6	.0	1.0	5.7	.0	.0	.0	6.7	.0	.6	3.2	.0	.0	.0	3.8
7	.0	.0	.0	2.9	.0	.0	2.9	.0	.0	.0	1.6	.0	.0	1.6
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	1.0	.0	.0	1.0	.0	.0	.0	.3	.0	.0	.3
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	15.2	15.6	3.8	.0	.0	34.6	.0	9.2	8.3	1.9	.0	.0	19.4

	E							SE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	2.2	.0	.0	.0	.0	2.2	.0	.0	.0	.0	.0	.0	.0
1-2	.0	3.8	2.5	.0	.0	.0	6.3	.0	1.3	.0	.0	.0	.0	1.3
3-4	.0	1.3	5.7	1.3	.0	.0	8.3	1.3	.0	.3	.0	.0	.0	1.6
5-6	.0	1.9	3.2	.0	.0	.0	5.1	.0	.3	.3	.0	.0	.0	.6
7	.0	.0	.0	1.3	.0	.0	1.3	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	9.2	11.4	2.5	.0	.0	23.2	1.3	1.6	.6	.0	.0	.0	3.5

PERIOD: (OVER-ALL) 1963-1970

OCTOBER

TABLE 18

AREA 0004 SHANGHAI
30.6N 122.1E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	.0	.0	.0	.0	.0

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	1.3	.0	.0	.0	1.3
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	1.3	.0	.0	.0	1.3

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	1.3	.0	.0	.0	.0	1.3
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.3	.0	.0	.0	.0	1.3

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	2.5	.0	.0	.0	.0	2.5
1-2	.0	5.1	1.6	.0	.0	.0	6.7
3-4	.0	.3	1.6	.0	.0	.0	1.9
5-6	.0	.0	2.9	.0	.0	.0	2.9
7	.0	1.3	.0	.6	.0	.0	1.9
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	9.2	6.0	.6	.0	.0	15.9

OCTOBER

PERIOD: (OVER-ALL) 1963-1970

AREA 0004 SHANGHAI
30.6N 122.1E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	2.5	7.5	.0	.0	.0	.0	10.0	
1-2	.0	20.0	8.8	.0	.0	.0	28.8	
3-4	1.3	11.3	18.8	1.3	.0	.0	32.5	
5-6	.0	3.8	15.0	.0	.0	.0	18.8	
7	.0	2.5	.0	6.3	.0	.0	8.8	
8-9	.0	.0	.0	.0	.0	.0	.0	
10-11	.0	.0	.0	1.3	.0	.0	1.3	
12	.0	.0	.0	.0	.0	.0	.0	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	3.8	45.0	42.5	8.8	.0	.0	100.0	80

PERIOD: (OVER-ALL) 1952-1970

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	5.3	9.6	21.3	6.4	5.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	45	3
6-7	.0	.0	5.3	16.0	6.4	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27	5
8-9	.0	.0	1.1	2.1	4.3	.0	2.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	9	7
10-11	.0	.0	.0	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1	8
12-13	.0	.0	.0	.0	.0	.0	1.1	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2	12
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	3.2	1.1	4.3	1.1	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10	3
TOTAL	8	10	30	24	15	1	4	1	1	0	0	0	0	0	0	0	0	0	0	94	4
PCT	8.5	10.6	31.9	25.5	16.0	1.1	4.3	1.1	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PERIOD: (OVER-ALL) 1963-1969

NOVEMBER

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.2E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

N

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	5.5	1.5	.0	.0	.0	7.0
3-4	.0	5.1	5.1	.0	.0	.0	10.3
5-6	.0	.0	3.7	1.5	.0	.0	5.1
7	.0	.0	2.6	2.6	1.5	.0	6.6
8-9	.0	.0	1.5	.0	.0	.0	1.5
10-11	.0	.0	1.5	.0	.0	.0	1.5
12	.0	.0	.0	.0	1.5	.0	1.5
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	10.7	15.8	4.0	2.9	.0	33.5

NE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.5	.0	.0	.0	.0	1.5
1-2	.0	2.9	.0	.0	.0	.0	2.9
3-4	.0	1.8	1.5	.0	.0	.0	3.3
5-6	.0	.0	1.8	.0	.0	.0	1.8
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	1.5	.0	.0	1.5
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	6.3	3.3	1.5	.0	.0	11.0

E

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.5	1.5	.0	.0	.0	2.9
1-2	.0	7.4	.0	.0	.0	.0	7.4
3-4	.0	1.5	3.7	.0	.0	.0	5.1
5-6	.0	.0	1.5	.0	.0	.0	1.5
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	10.3	6.6	.0	.0	.0	16.9

SE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	1.8	.0	.0	.0	.0	1.8
5-6	.0	.0	1.5	.0	.0	.0	1.5
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.8	1.5	.0	.0	.0	3.3

TABLE 18

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	1.5	.0	.0	.0	1.5
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	1.1	2.6	.0	.0	.0	3.7
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.1	4.0	.0	.0	.0	5.1

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	1.5	1.5	.0	.0	.0	.0	2.9
3-4	.0	.0	.4	.0	.0	.0	.4
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.5	1.5	.4	.0	.0	.0	3.3

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	1.1	.0	.0	.0	1.1
3-4	.0	.0	.0	.0	.0	.0	.0
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	1.1	.0	.0	.0	1.1

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.5	.0	.0	.0	.0	1.5
1-2	.0	6.3	4.8	.0	.0	.0	11.0
3-4	.0	.4	4.4	.0	.0	.0	4.8
5-6	.0	.0	3.3	1.5	.0	.0	4.8
7	.0	.0	1.8	.4	.0	.0	2.2
8-9	.0	.0	1.5	.0	.0	.0	1.5
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	8.1	15.8	1.8	.0	.0	25.7

NOVEMBER

PERIOD: (OVER-ALL) 1963-1969

AREA 0004 SHANGHAI
30.5N 122.2E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	1.4	4.3	2.9	.0	.0	.0	8.7	
1-2	1.4	23.2	7.2	.0	.0	.0	31.9	
3-4	.0	11.6	17.4	.0	.0	.0	29.0	
5-6	.0	.0	11.6	2.9	.0	.0	14.5	
7	.0	.0	4.3	2.9	1.4	.0	8.7	
8-9	.0	.0	2.9	.0	.0	.0	2.9	
10-11	.0	.0	1.4	.0	.0	.0	1.4	
12	.0	.0	.0	.0	1.4	.0	1.4	
13-16	.0	.0	.0	1.4	.0	.0	1.4	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	2.9	39.1	47.8	7.2	2.9	.0	100.0	69

PERIOD: (OVER-ALL) 1949-1969

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	7.8	14.4	17.8	4.4	4.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	44	3
6-7	.0	.0	5.6	11.1	2.2	1.1	1.1	.0	2.2	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	22	7
8-9	.0	.0	2.2	2.2	1.1	2.2	.0	2.2	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	11	8
10-11	.0	.0	.0	.0	.0	1.1	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2	9
12-13	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1	3
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0	
INDET	2.2	4.4	4.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10	2
TOTAL	9	17	28	16	7	4	2	2	4	1	0	0	0	0	0	0	0	0	0	90	4
PCT	10.0	18.9	31.1	17.8	7.8	4.4	2.2	2.2	4.4	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PERIOD: (OVER-ALL) 1963-1971

DECEMBER

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.2E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

N

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	1.2	1.2	.0	.0	.0	.0	2.4
1-2	.0	4.3	4.6	.0	.0	.0	8.8
3-4	.0	.0	7.3	1.2	.0	.0	8.5
5-6	.0	.0	4.9	3.0	.0	.0	7.9
7	.0	.0	3.4	1.2	.0	.0	4.6
8-9	.0	.0	.0	.9	.0	.0	.9
10-11	.0	.0	.0	1.2	.0	.0	1.2
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	1.2	5.5	20.1	7.6	.0	.0	34.5

NE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	1.8	2.7	.0	.0	.0	4.6
3-4	.0	.0	5.5	1.2	.0	.0	6.7
5-6	.0	.0	.3	.3	.0	.0	.6
7	.0	.0	.3	1.2	.0	.0	1.5
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	1.2	.0	.0	.0	1.2
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	1.8	10.1	2.7	.0	.0	14.6

E

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	3.4	1.2	.0	.0	.0	4.6
3-4	.0	1.2	2.1	.0	.0	.0	3.4
5-6	.0	.0	2.1	.0	.0	.0	2.1
7	.0	.9	.0	.0	.0	.0	.9
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	5.5	5.5	.0	.0	.0	11.0

SE

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	1.2	.0	.0	.0	1.2
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.3	.0	.0	.0	.0	.3
8-9	.0	.0	1.2	.0	.0	.0	1.2
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.3	2.4	.0	.0	.0	2.7

PERIOD: (OVER-ALL) 1963-1971

DECEMBER

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.2E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	.0	.9	.0	.0	.0	.9
3-4	.0	.0	2.1	.0	.0	.0	2.1
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	.0	3.0	.0	.0	.0	3.0

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	2.4	1.5	.0	.0	.0	4.0
3-4	.0	.0	.3	.0	.0	.0	.3
5-6	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0
8-9	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	2.4	1.8	.0	.0	.0	4.3

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	1.2	.0	.0	.0	.0	1.2
1-2	.0	.0	.0	.0	.0	.0	.0
3-4	.0	.0	2.1	.0	.0	.0	2.1
5-6	.0	1.2	.0	.0	.0	.0	1.2
7	.0	.0	.9	.0	.0	.0	.9
8-9	.0	.0	1.2	.0	.0	.0	1.2
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	2.4	4.3	.0	.0	.0	6.7

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.0	.0	.0	.0	.0	.0
1-2	.0	2.7	2.4	.0	.0	.0	5.2
3-4	.0	.0	6.1	.0	.0	.0	6.1
5-6	.0	.0	3.7	4.0	.0	.0	7.6
7	.0	.0	.3	.0	1.2	.0	1.5
8-9	.0	.0	.0	.3	.0	.0	.3
10-11	.0	.0	.0	2.4	.0	.0	2.4
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	2.7	12.5	6.7	1.2	.0	23.2

PERIOD: (OVER-ALL) 1963-1971

AREA 0004 SHANGHAI
30.5N 122.2E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	2.4	2.4	.0	.0	.0	.0	4.8	
1-2	.0	14.5	13.3	.0	.0	.0	27.7	
3-4	.0	1.2	26.5	2.4	.0	.0	30.1	
5-6	.0	1.2	10.8	7.2	.0	.0	19.3	
7	.0	1.2	4.8	2.4	1.2	.0	9.6	
8-9	.0	.0	2.4	1.2	.0	.0	3.6	
10-11	.0	.0	.0	3.6	.0	.0	3.6	
12	.0	.0	1.2	.0	.0	.0	1.2	
13-16	.0	.0	.0	.0	.0	.0	.0	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	2.4	20.5	59.0	16.9	1.2	.0	100.0	83

PERIOD: (OVER-ALL) 1950-1971

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	3.2	19.4	16.1	4.3	.0	2.2	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	43	3
6-7	.0	.0	3.2	5.4	7.5	4.3	.0	1.1	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	21	7
8-9	.0	.0	.0	1.1	7.5	.0	.0	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	9	8
10-11	.0	.0	.0	.0	1.1	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3	8
12-13	.0	.0	.0	.0	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1	10
>13	.0	.0	.0	.0	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1	10
INDET	1.1	1.1	5.4	4.3	2.2	.0	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	15	5
TOTAL	4	19	23	14	17	8	4	1	2	1	0	0	0	0	0	0	0	0	0	93	5
PCT	4.3	20.4	24.7	15.1	18.3	8.6	4.3	1.1	2.2	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	

PERIOD: (OVER-ALL) 1963-1971

ANNUAL

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

	N							NE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.5	.4	.0	.0	.0	.0	1.0	.4	1.3	.1	.0	.0	.0	1.8
1-2	.2	4.2	2.0	.0	.0	.0	6.4	.3	4.1	1.7	.0	.0	.0	6.1
3-4	.0	2.3	6.7	.2	.0	.0	9.2	.0	1.7	3.5	.1	.0	.0	5.3
5-6	.0	.3	3.5	1.1	.0	.0	4.9	.0	.1	2.5	.5	.0	.0	3.1
7	.0	.0	2.3	1.9	.1	.0	4.3	.0	.0	.4	.3	.0	.0	.6
8-9	.0	.0	.3	.8	.0	.0	1.0	.0	.0	.2	.1	.0	.0	.3
10-11	.0	.0	.1	.4	.0	.0	.5	.0	.0	.0	*	.0	.0	*
12	.0	.0	.0	.0	.2	.0	.2	.0	.0	.1	.0	.0	.0	.1
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.1
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.7	7.2	14.9	4.3	.3	.0	27.5	.7	7.1	8.5	1.1	.0	.0	17.4

	E							SE						
HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.2	1.1	.2	.0	.0	.0	1.6	.5	.8	*	.0	.0	.0	1.3
1-2	.1	3.2	1.0	.0	.0	.0	4.3	.2	3.7	.9	.0	.0	.0	4.7
3-4	.0	1.0	1.4	.1	.0	.0	2.5	.1	1.2	.9	.0	.0	.0	2.1
5-6	.0	.3	1.2	.1	.0	.0	1.6	.0	*	.4	.0	.0	.0	.5
7	.0	.1	.3	.1	.0	.0	.5	.0	*	*	.1	.0	.0	.2
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.1	.0	.0	.3
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.1
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.3	5.7	4.0	.3	.0	.0	10.4	.8	5.7	2.5	.2	.0	.0	9.2

PERIOD: (OVER-ALL) 1963-1971

ANNUAL

TABLE 18

AREA 0004 SHANGHAI
30.5N 122.3E

PCT FREQ OF WIND SPEED (KTS) AND DIRECTION VERSUS SEA HEIGHTS (FT)

S

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.6	.2	.0	.0	.0	.9
1-2	.0	4.5	1.5	.0	.0	.0	6.0
3-4	.0	1.6	3.0	.1	.0	.0	4.6
5-6	.0	.1	1.8	.2	.0	.0	2.1
7	.0	.0	.5	.0	.0	.0	.5
8-9	.0	.0	.1	.0	.0	.0	.1
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.1	.0	.0	.0	.1
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.0	6.8	7.2	.2	.0	.0	14.2

SW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.0	.8	.0	.0	.0	.0	.8
1-2	.1	2.0	1.0	.0	.0	.0	3.1
3-4	.0	.6	1.0	*	.0	.0	1.6
5-6	.0	.1	.6	.0	.0	.0	.8
7	.0	.0	.1	.1	.0	.0	.2
8-9	.0	.0	.1	.0	.0	.0	.1
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	*	.0	.0	.0	*
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.1	3.4	2.8	.1	.0	.0	6.5

W

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.1	.3	.0	.0	.0	.0	.4
1-2	.0	.5	.5	.0	.0	.0	1.0
3-4	.0	.2	.5	.0	.0	.0	.7
5-6	.0	.1	.0	.0	.0	.0	.1
7	.0	.1	.3	.0	.0	.0	.4
8-9	.0	.0	.1	.0	.0	.0	.1
10-11	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.1	1.2	1.3	.0	.0	.0	2.6

NW

HGT	1-3	4-10	11-21	22-33	34-47	48+	PCT
<1	.2	.6	.1	.0	.0	.0	.9
1-2	.0	1.7	1.4	.0	.0	.0	3.1
3-4	.0	.6	2.3	.1	.0	.0	3.0
5-6	.0	.0	.9	.6	.0	.0	1.5
7	.0	.1	.7	.2	.1	.0	1.2
8-9	.0	.0	.1	.1	.0	.0	.2
10-11	.0	.0	.0	.2	.1	.0	.3
12	.0	.0	.0	.1	.0	.0	.1
13-16	.0	.0	.0	.0	.0	.0	.0
17-19	.0	.0	.0	.0	.0	.0	.0
20-22	.0	.0	.0	.0	.0	.0	.0
23-25	.0	.0	.0	.0	.0	.0	.0
26-32	.0	.0	.0	.0	.0	.0	.0
33-40	.0	.0	.0	.0	.0	.0	.0
41-48	.0	.0	.0	.0	.0	.0	.0
49-60	.0	.0	.0	.0	.0	.0	.0
61-70	.0	.0	.0	.0	.0	.0	.0
71-86	.0	.0	.0	.0	.0	.0	.0
87+	.0	.0	.0	.0	.0	.0	.0
TOT PCT	.2	3.0	5.6	1.4	.2	.0	10.4

ANNUAL

PERIOD: (OVER-ALL) 1963-1971

AREA 0004 SHANGHAI
30.5N 122.3E

TABLE 18 (CONT)

WIND SPEED (KTS) VS SEA HEIGHT (FT)

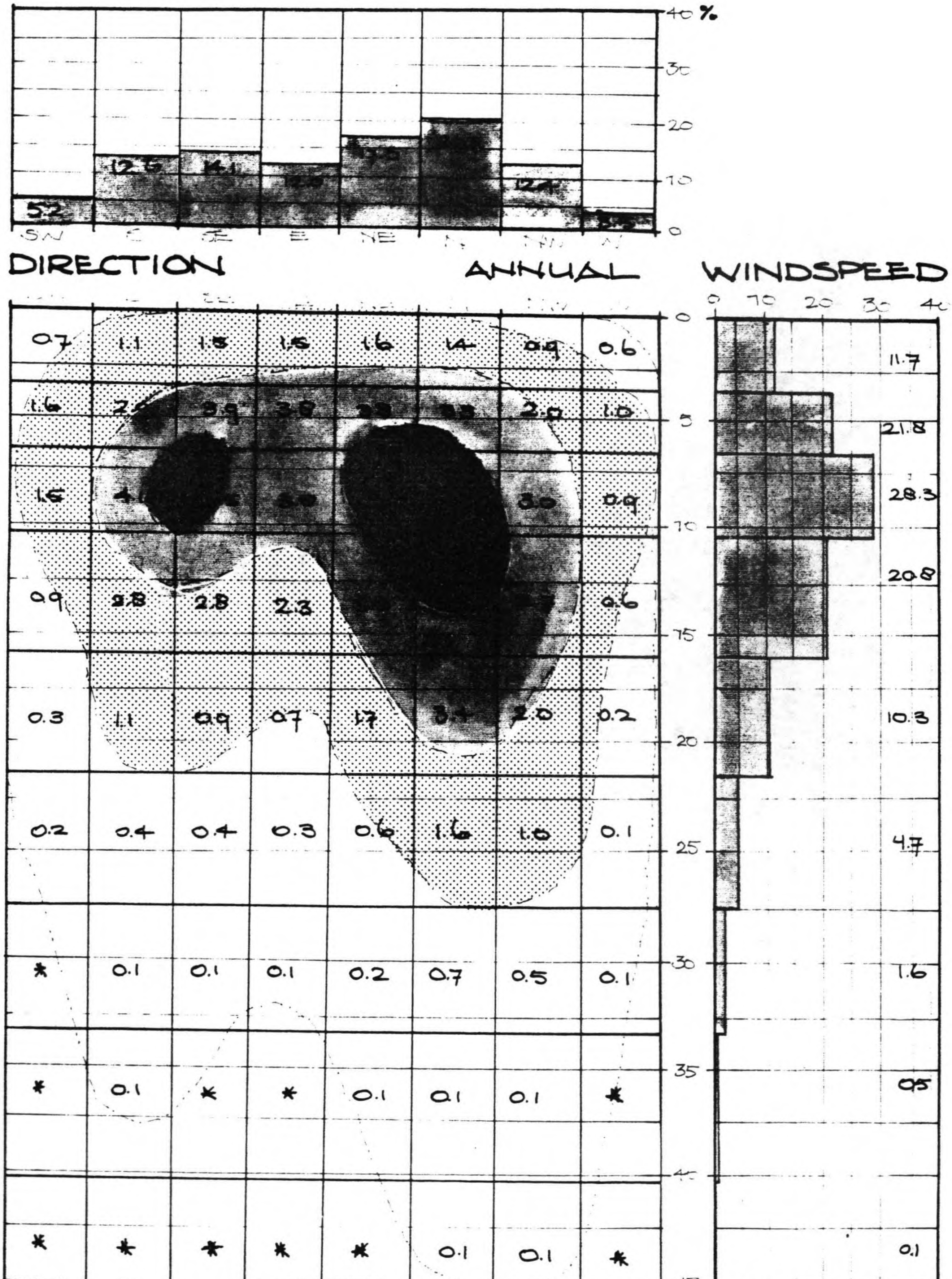
HGT	0-3	4-10	11-21	22-33	34-47	48+	PCT	TOT OBS
<1	5.0	5.8	.7	.0	.0	.0	11.5	
1-2	.8	23.4	9.7	.0	.0	.0	34.0	
3-4	.1	9.0	18.9	.6	.0	.0	28.6	
5-6	.1	1.0	10.9	2.4	.0	.0	14.4	
7	.0	.3	4.5	2.7	.2	.0	7.7	
8-9	.0	.0	1.1	1.1	.0	.0	2.2	
10-11	.0	.0	.2	.6	.1	.0	.9	
12	.0	.0	.2	.1	.2	.0	.6	
13-16	.0	.0	.0	.1	.0	.0	.1	
17-19	.0	.0	.0	.0	.0	.0	.0	
20-22	.0	.0	.0	.0	.0	.0	.0	
23-25	.0	.0	.0	.0	.0	.0	.0	
26-32	.0	.0	.0	.0	.0	.0	.0	
33-40	.0	.0	.0	.0	.0	.0	.0	
41-48	.0	.0	.0	.0	.0	.0	.0	
49-60	.0	.0	.0	.0	.0	.0	.0	
61-70	.0	.0	.0	.0	.0	.0	.0	
71-86	.0	.0	.0	.0	.0	.0	.0	
87+	.0	.0	.0	.0	.0	.0	.0	
TOT PCT	6.1	39.6	46.2	7.7	.5	.0	100.0	918

PERIOD: (OVER-ALL) 1950-1968

TABLE 19

PERCENT FREQUENCY OF WAVE HEIGHT (FT) VS WAVE PERIOD (SECONDS)

PERIOD (SEC)	<1	1-2	3-4	5-6	7	8-9	10-11	12	13-16	17-19	20-22	23-25	26-32	33-40	41-48	49-60	61-70	71-86	87+	TOTAL	MEAN HGT
<6	3.9	14.7	17.4	6.3	2.6	.8	.0	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	551	3
6-7	.0	1.7	6.6	8.6	4.9	1.9	.7	.3	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	303	5
8-9	.0	.4	.9	2.3	3.7	1.2	.8	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	125	7
10-11	.0	.1	.0	.5	.2	.8	.4	.3	.1	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	32	9
12-13	.0	.0	.2	.1	.1	.2	.4	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	16	8
>13	.0	.0	.0	.0	.0	.0	.1	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	3	14
INDET	4.2	3.1	3.8	1.7	1.0	.1	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	176	3
TOTAL	98	243	346	239	148	62	34	16	12	8	0	0	0	0	0	0	0	0	0	1206	4
PCT	8.1	19.9	29.0	19.6	12.4	5.2	2.8	1.3	1.0	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	100.0	



DIRECTION
ANNUAL
WINDSPEED
%
KNOTS
SW
E
NE
W
5.2
12.6
14.1
0.7 1.1 1.3 1.5 1.6 1.4 0.9 0.6
0.9 2.8 2.8 2.3
0.3 1.1 0.9 0.7 1.7 3.4 2.0 0.2
0.2 0.4 0.4 0.3 0.6 1.6 1.0 0.1
* 0.1 0.1 0.1 0.2 0.7 0.5 0.1
* 0.1 * * 0.1 0.1 0.1 *
* * * * * 0.1 0.1 *
11.7
21.8
28.3
20.8
10.3
4.7
1.6
0.5
0.1