Environmental Statement

Appendix C

Wave Conditions Report

C

PROJECT NR: 30.3126

EASTSIDE DEVELOPMENT, GIBRALTAR

EBG *Marine Engineering & Construction*

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Volume 2: Normal wave conditions

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Sofia Caires, Carline Bos

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ABSTRACT:

EBG is involved in the development of a new scheme on the east side of Gibraltar. To support the development phase of the scheme, WL | Delft Hydraulics was requested by EBG to execute various hydraulic studies to provide relevant input to the Environmental Impact Assessment process concerning the scheme.

The hydraulic studies carried out to support the Environmental Impact Assessment process address the following aspects:

1. Flow conditions
2. Normal wave conditions
3. Coastal morphology

This report presents the results of the above item 2: Normal wave conditions

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Executive Summary

General
EBG is involved in the development of a new scheme on the east side of Gibraltar. To support the development phase of the scheme, WL | Delft Hydraulics was requested by EBG to execute various hydraulic studies to provide relevant input to the Environmental Impact Assessment process concerning the scheme. The project is referred to as “Eastside, Gibraltar”.

As part of the study the normal wave conditions at the project site were determined as well as the influence of the scheme on the normal wave conditions at the project site. The approach and results of the study are presented in this report.

Study approach
There are no historic recorded wave data available in the immediate vicinity of the planned scheme. Therefore, the wave conditions for the project were derived on the basis of offshore wind and wave data. The offshore wave conditions were transformed to the project site using numerical wave propagation modelling to derive the normal wave conditions for the scheme development.

The following offshore data were used in the study:

- 9 years (1997-2005) of buoy measurements (Mar de Alboran buoy) maintained by Puertos del Estado;
- 7 years (1999-2005) of wave data from the ECMWF operational wave model;
- 7 years (1999-2005) of wind data from the Puertos del Estado operational wave model.

The Mar de Alboran buoy is regularly maintained and calibrated and provides actual measured wave conditions. Therefore these data are considered most reliable. However, due to several gaps in the data coverage of the available buoy data, these data alone could not be used to derive the offshore normal wave conditions for the project. However, the measurements provided valuable data for the validation and calibration of the available model data. After calibration of the model data against the buoy data the offshore model data have been used as a basis for the present study providing offshore wave boundary conditions for both easterly (generated at the Mediterranean Sea) and westerly (penetrating through the Strait of Gibraltar) waves.

The offshore wave conditions were transformed to the project site using the third generation shallow water wave model SWAN. Simulations were carried out for a range of wave conditions covering the offshore wave climate. The most predominant and higher waves are approaching the site from East/Southeast and are generated in Mediterranean and Alboran Sea. At the project site another important wave component is formed by waves penetrating through the Strait of Gibraltar and approaching the site from South/Southeast. Both wave components were considered in the wave transformation to determine the normal wave conditions at the project site.

Scheme Impacts

Simulations were carried out for the existing situation and for the future situation with the scheme to evaluate its influence on the normal wave conditions along the coast. As expected, immediately north of the planned scheme waves from south and southeasterly directions are shielded and shift a little in direction, while south of the scheme, northerly and northeasterly waves are slightly blocked by the scheme. The area influenced by the scheme is however very limited. On the basis of a comparison between the wave climates with and without the scheme it was concluded that beyond a distance of about 500 m north and 200 to the south of the scheme the influence of the scheme on the normal wave climate is negligible.

Assuming that the sand for the landfill of the scheme will be dredged uniformly in the borrow areas, the impact of the borrow areas is expected to be negligible. The wave field surrounding the borrow areas can however be affected, if dredging is done unevenly creating, for instance, a deep channel or pit.

In-combination Effects

Considering the small scale of the Both Worlds Project at Sandy Bay, the impact of the Both Worlds Project on the normal wave climate will be very small and limited to a small part of Sandy Bay only. No cumulative effects are expected as a result of the combined scheme and Both Worlds Project developments.

Transboundary Effects

Given the above indicated limited area affected by the scheme, there are no transboundary effects into the Spanish waters.

Executive Summary

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Symbol	Units	Description
H_s	m	Significant wave height
T_p	s	Peak period
MWD	ºN	Mean wave direction
U_{10}	m/s	Wind speed at a height of 10m
θ_w	ºN	Wind direction
u_*	m/s	Friction velocity
z_0	m	surface roughness
α		Charnock constant
κ		von Karman constant
g	m/s^2	acceleration of gravity

1 Introduction

1.1 Background

EBG (Europese Bouw Groep) is involved in the development of a new scheme on the east side of Gibraltar. Figure 1.1 indicates the location of the project site. The scheme is planned at the existing Rubble Tip area between Eastern Beach to the north and Catalan Bay to the south. Directly north of Eastern Beach lies the Gibraltar airport runway and the Spanish border. Directly south of Catalan Bay the coastline is formed by rock outcrops. Sandy Bay is located further south (see Figure 1.2).

To support the schemes development phase, WL | Delft Hydraulics was requested by EBG to execute various hydraulic studies to provide relevant input to the Environmental Impact Assessment (EIA) process concerning the scheme. The project is referred to as "Eastside Gibraltar".

EIA scenarios

In accordance with EIA legislation and guidance applied in Gibraltar, various impact scenarios have to be assessed. A brief description of these scenarios is given below.

Eastside Gibraltar Impacts
The development is subject to the EIA process, which requires the project proponent to provide environmental information including descriptions of the likely significant impacts of the proposals in terms of changes to the existing environmental conditions. The proposals include a high quality mixed use residential development on the east side of Gibraltar. Figure 1.2 shows the proposed scheme. The site of the proposed development will utilise the existing area of reclaimed land (presently a rubble tip) and will require a further eastward land reclamation of about 100m.

It is proposed that fill material for the land reclamation will be dredged from the borrow areas as indicated in Figure 1.1. If the material is dredged from one of the borrow areas the expected average deepening will be 0.4m (southern borrow area) or 0.9m (northern borrow area), see EBG (2007).

In-combination Effects
As part of the EIA the impacts of the scheme have to be considered in combination with another development envisaged at the east side. This development envisaged at the east side and considered in this scenario is the Both Worlds Project at Sandy Bay. This relatively small project is located at the southern end of Sandy Bay, see Figure 1.3. The development comprises a small land reclamation with 10-30m seaward extension over a shore parallel distance of about 50-60m. The land reclamation will be protected by a shore protection.

Transboundary Effects
Given the close vicinity of the project location to the Spanish border, the transboundary effects of the above scenarios have to be considered in the EIA process. The location of the border, as derived from the Admiralty Charts, has been included in Figures 1.1 to 1.3, and delineates the border between Gibraltar and Spain's territorial waters for the purpose of assessing transboundary effects.

1.2 Scope of work

The scope of work for the hydraulic studies covers the following:

1. Flow conditions
The flow conditions at the project site have been determined by numerical flow modelling. For this purpose a flow model was prepared for the project area. Simulations were carried out with and without the scheme. This part of the study covers:

- Assessment of impact on tidal characteristics
- Determination of impact on storm surge behaviour
- Assessment of impact on current flow patterns
- Prediction of pollutant dispersion
- Assessment of beach cleansing and bathing water quality

2. Normal wave conditions
Wave conditions were studied to determine the normal wave conditions along the coast at the project site. Simulations were carried out with and without the scheme. This part of the study covers:

- Assessment of offshore and nearshore wave conditions
- Impact of the scheme on the annual nearshore wave climate

3. Coastal morphology
Various coastal morphology aspects were determined using 2D and 1D morphological models. This part of the study includes:

- Assessment of coastal impact
- Determination of sediment infill rates of dredged areas
- Prediction of dredged plume dispersion
- Impact of the development on the cross-shore beach profiles
- Guidelines on beach maintenance work

The approach and results of the above three study items have been reported in separate volumes.

1.3 Aim of the present report

This report presents study item: *2) Normal wave conditions*.
The aim of the study reported here is to determine the normal wave climate at the project site and to assess the impact of the proposed layout on the mean wave climate.

1.4 Approach

There are no historic recorded wave data available in the immediate vicinity of the planned scheme. In order to define the mean wave climate in the vicinity of the proposed scheme, the best wave and wind data available for the region were compiled, validated, calibrated, and used to determine the mean wave climate offshore. A wave modelling study, forced by the mean wind climate, was then carried out to transfer the determined offshore mean wave climate to the location of interest.

In the initial stages of this study we have looked for the most suitable measurements and the best model wind and wave data available in the region. Northeast of the planned development site there is an operating buoy measuring both waves and winds, whose measurements can be used to define the characteristics of the waves and to calibrate the available model data.

After considering all the suitable wave model data available offshore of the development site, we have concluded that the best wave model data available is the data from the operational European Centre for Medium-range Weather Forecast (ECMWF) wave model. This model data provides insight into the spatial and temporal variation of the wave conditions in the project area, which allows for the determination of offshore wave boundary conditions for both easterly (generated at the Mediterranean Sea) and westerly (penetrating through the Strait of Gibraltar) waves.

Also after considering all the suitable model wind field data for the region, it was concluded that the best are those of the Spanish meteorological institute high resolution limited area model (HIRLAM). As the name suggests, these winds have relatively high resolution and are produced by a local model in which the orography and coastline are better represented than in other models (such as ECMWF). The ECMWF and HIRLAM data were validated against the buoy measurements and calibrated when necessary and then used to define the normal wind and wave conditions offshore.

The third generation shallow water wave model SWAN (Booij et al, 1999), forced using the estimated mean wind climate for the region, was used to transform the offshore normal wave conditions to the vicinity of the proposed scheme. In order to make sure that the relevant bathymetry was accurately accounted for in the SWAN model computations three grids where used: a coarse large domain grid, a fine coastal grid and even finer grid for the proposed scheme region. In order to assess the effect of the scheme, the nearshore mean wave climate computations were carried out with and without the presence of the proposed layout.

2 Data description and validation

2.1 Data sources

The following offshore wave and wind data were used in the study:

- 9 years of buoy measurements (Mar de Alboran buoy, located at 36º 13.931'N 5º 3.071'W, directional waverider, 1997-2005), wind and wave data;
- 7 years of wave analysis data (ECMWF model data, 3rd generation WAM wave model, 1999-2005);
- 7 years of analysis HIRLAM wind data from the Puertos del Estado operational wave model (1999-2005).

The locations of the data sources are indicated in Figure 2.1. The green line in Figure 2.1 indicates the overall wave modelling area.

2.1.1 Buoy measurements

The Spanish *Puertos del Estado* carry out wave measurements at the *Mar de Alboran* site (see Figure 2.1), where the water depth is about 585 m. The measurement site has been operational since February 1997. Various types of buoys have been used at this location, the presently operational buoy is a Seawatch manufactured by Oceanor (http://www.puertos.es/externo/clima/Rayo/Seawatch.html). According to information from Puertos del Estado the buoys undergo maintenance every three months and every four years the accelerometers are calibrated by the manufacturer.

We have acquired from Puertos del Estado all available measurements until the end of 2005. The data have been checked for outliers and consistency with other measurements in the area (e.g. offshore Ceuta).

2.1.1.1 Waves

The wave parameters we have obtained were the significant wave height (H_s), the peak period (T_p) and the mean wave direction (MWD). MWD data is only available since 2003. The available data is hourly, but because the ECMWF model data is 6-hourly at synoptic times (0h, 6h, 12h, and 18h) we will only be considering 6-hourly data.

There are several gaps in the buoy data, the gaps in the H_s and T_p being much shorter than those in the MWD data. Gaps in buoy measurements are common, and they can be due to the buoy not being operational for a long period, to data processing problems, to the loss of a single observation because of communication problems, etc. However, in the present case the amount of missing MWD measurements is quite extreme. Table 2.1 presents the percentage per month of valid H_s and T_p measurements from 1999 until 2005 and Table 2.2 the corresponding percentage per month of valid MWD measurements.

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	99.2	100.0	98.4	71.7	94.4	58.3	98.4	98.4	95.0	98.4	100.0	99.2
2000	98.4	64.7	26.6	15.8	84.7	99.2	99.2	97.6	95.0	58.1	0.0	80.7
2001	97.6	98.2	97.6	99.2	98.4	89.2	0.0	30.7	90.8	11.3	65.8	100.0
2002	100.0	7.1	60.5	97.5	98.4	100.0	79.0	100.0	97.5	100.0	98.3	93.6
2003	96.8	11.6	84.7	94.2	98.4	37.5	37.9	94.4	95.8	97.6	69.2	0.8
2004	0.0	0.0	0.0	81.7	33.9	100.0	100.0	100.0	99.2	100.0	16.7	21.0
2005	68.6	99.1	86.3	50.8	96.8	61.7	0.0	0.0	58.3	99.2	99.2	99.2

Table 2.1 Percentage of valid 6-hourly H_s and T_p buoy measurements

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	0.0	0.0	0.0	0.0	85.5	35.0	0.0	0.0	63.3	50.8	0.0	0.0
2004	0.0	0.0	0.0	0.0	30.7	100.0	100.0	53.2	0.0	0.0	0.0	0.0
2005	55.7	87.5	16.9	0.0	63.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2.2 Percentage of valid 6-hourly MWD buoy measurements

No mean wave climate can be defined using these observations since they are too few and the resulting climate would be biased in terms of monthly representation of the data (there are no MWD measurements available every month). However, these data provide useful information to validate and calibrate the ECMWF data.

2.1.1.2 Winds

Wind measurements are also available from the Mar de Alboran buoy. The buoy measures the wind speed and the wind direction (θ_w). However, the buoy anemometer is at a height of 3 m. In order to compare the measurements with the HIRLAM wind data the measurements were adjusted to a height of 10 m (the height at which winds are considered by wave models).

The adjustment was computed assuming atmospheric steady-state neutral stability (Komen et al, 1994). Under such conditions the vertical wind profile is given by the following logarithmic law:

$$U(z) = \frac{u_*}{\kappa} \ln(\frac{z}{z_0}) \text{, with } z_0 = \alpha \frac{u_*^2}{g} \text{,}$$

where u_* is the friction velocity, z_0 is the surface roughness, $\alpha = 0.018$ is the Charnock constant, $\kappa = 0.4$ the von Karman constant and $g = 9.81$ the acceleration of gravity. An iterative algorithm is used to determine the friction velocity from the measurements at a height of 3 m and then the corresponding wind velocity at 10 m (U_{10}) is computed.

As was the case for the wave measurements, there are several gaps in the buoy wind measurements. Table 2.3 presents the percentage per month of valid U_{10} and θ_w 6-hourly measurements.

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	100.0	100.0	100.0	69.2	94.4	58.3	100.0	99.2	100.0	100.0	99.2	100.0
2000	98.4	62.9	26.6	15.8	83.9	100.0	99.2	98.4	99.2	56.5	0.0	84.7
2001	96.8	94.6	29.0	0.0	0.0	0.0	0.0	30.6	90.8	11.3	65.0	100.0
2002	100.0	7.1	62.1	100.0	100.0	100.0	71.8	0.0	0.0	0.0	0.0	0.0
2003	3.2	11.6	84.7	95.8	99.2	38.3	37.9	93.5	95.0	96.0	99.2	64.5
2004	27.4	0.0	0.0	0.0	0.0	0.0	0.0	46.0	99.2	99.2	15.8	21.0
2005	60.5	99.1	93.5	0.0	60.5	59.2	0.0	0.0	58.3	98.4	100.0	99.2

Table 2.3 Percentage of valid 6-hourly U_{10} and θ_w buoy measurements

2.1.2 ECMWF wave data

ECMWF wave data from the operational limited area wave model (LAW) is available for the region of interest with 27 km resolution since 1996. The wave model used is WAM (Janssen et al, 2005), and data is available since 1996. However, the LAW model originally covered only the Mediterranean Sea (there was no wave propagation from the Atlantic through the Strait of Gibraltar). The situation changed with the extension in late October 1998 of their model to many areas around Europe. Still, the Mediterranean Sea is not a very easy area for wave modelling. The quality of the wind forcing is often the problem, especially near the coast, and there are still several wave model deficiencies to be solved. The ECMWF estimates of high waves have a tendency to be underestimations. However, the meteorological conditions are usually well represented, resulting in a good correlation with measurements (see e.g. Caires et al, 2004).

We have acquired 6-hourly time series of analysed ECMWF H_s, T_p and MWD data from 1999 to 2005 for three LAW model grid points located at: *36ºN, 5.5ºW*, *36ºN, 5ºW* and *36.25ºN, 5ºW*. We will refer to these grid points as the *West*, the *Southeast* and the *Northeast* grid points, respectively. The location of the grid points is given in Figure 2.1.

The Northeast grid point is located quite close to the Mar de Alboran buoy and we have used the buoy measurements to validate the ECMWF data for this location (see Section 2.2).

2.1.3 HIRLAM wind data

The HIRLAM wind data is used for forcing the Puertos del Estado operational wave model, and therefore the data can be acquired from them only for the grid points of their operational wave model where wave data is also available.

We have acquired from Puertos del Estado time series of 6-hourly U_{10} data from 1999 to 2005 for the locations indicated in Figure 2.1. One of the locations is quite close to the location of the Mar de Alboran buoy and we will compare the HIRLAM data for that location with the buoy measurements.

The model data available from Puertos del Estado also contains gaps. These are due to different operational forecast problems. Table 2.4 presents the percentage per month of valid U_{10} and θ_w 6-hourly HIRLAM data.

Year\Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.2
2000	100.0	100.0	100.0	100.0	100.0	100.0	93.5	93.5	100.0	83.9	91.7	94.4
2001	87.9	98.2	100.0	88.3	98.4	76.7	25.0	81.5	95.0	100.0	95.0	98.4
2002	100.0	96.4	96.8	98.3	99.2	79.2	96.8	96.8	91.7	80.6	91.7	98.4
2003	98.4	96.4	93.5	100.0	87.1	76.7	98.4	91.9	76.7	100.0	98.3	96.8
2004	46.0	71.6	98.4	85.0	96.8	91.7	95.2	79.8	77.5	77.4	100.0	92.7
2005	79.8	98.2	91.9	100.0	100.0	96.7	100.0	67.7	100.0	100.0	90.8	68.5

Table 2.4 Percentage of valid 6-hourly U_{10} and θ_w HIRLAM data

2.2 Data Validation

2.2.1 ECMWF wave data

Comparisons between the buoy measurements and the ECMWF Northeast data show that the model underestimates H_s and that there are discrepancies in MWD between the data sets that must be corrected for.

We start by showing comparisons between the H_s data and measurements. In these comparisons we do not require that MWD buoy measurements be available, so each data set has 7392 observations, which makes these comparisons quite robust. The discrepancies between the data depend on whether the ECMWF waves originate from the east quadrants or from the west quadrants. We wave therefore divided the data into two data sets. In the first data set the MWD of the ECMWF data is between 0 and 180º (a total of 4084 data points) and in the second set between 180º and 360º (a total of 3308 data points). Figures 2.2 and 2.3 show scatter plots between the ECMWF and the corresponding buoy observations. For each of the data sets a non-parametric method (Caires and Ferreira, 2005) was used to correct the ECMWF data. The non-parametric correction consists of grouping the data in classes. All the data within a class then get the same correction, assuming that these data have a similar origin. This correction is determined using the differences between the means. The scatter plots between the corrected ECMWF data and the corresponding buoy observations are also shown in the figures. It can be seen that the systematic errors have been removed and only some scatter between measurements and model results remains. This is judged to have a negligible effect on the resulting mean climate.

The mean wave direction of the ECMWF model data and the measurements were compared in a similar way. Figure 2.4 shows the scatter plot between the ECMWF and the corresponding buoy MWD observations. The top panel shows that the measured direction is more southerly than the model direction: from southeast (120-135°N) when the model direction is east (90°N) and from southwest (240-250°N) compared to west (260-270°N) for the model. The differences in wave directions were also corrected by using a non-parametric method. Comparisons between the buoy measurements and the correct ECMWF MWD data are also presented in Figure 2.4. The agreement between the two datasets improves considerably, though some scatter remains.

Figure 2.5 presents the wave rose of available buoy measurements and Figure 2.6 the corrected ECMWF Northeast data at the times that measurements are available. Comparing the two wave roses we can conclude that the ECMWF data were successfully calibrated.

In the comparisons presented so far no attention has yet been given to the peak wave period data. Figure 2.7 shows the scatter plot between the ECMWF and the corresponding buoy T_p observations. There is a significant scatter between the two data sets, but the majority of the data compares quite well with the measurements. Therefore we have decided to apply no correction to the ECMWF T_p data.

The above mentioned corrections were applied to the whole 1999-2005 ECMWF Northeast data and to the ECMWF Southeast data. Given the proximity between the Northeast and the Southeast grid points and the characteristics of the mean wave climate, we assume the deficiencies of the data sets from the two grid points to be similar.

No correction was applied to the ECMWF Western grid point data. Given that the ECMWF wave model is a deep water model and that shallow water and coast effect play a role in the wave propagation between the Northeast and the Western grid points, the Northeast grid point corrections cannot be applied to the Western grid point data. Only the quality of the Western waves coming from the western quadrants is of relevance for our study. We have therefore done some wave modelling trials, propagating the ECMWF Western data to the measurements location, and the results compared well with the buoy measurements. Its is therefore our opinion that the quality of ECMWF Western data is reasonable.

2.2.2 HIRLAM wind data

Figures 2.8 and 2.9 show the wind speed rose of the buoy measurements and of the HIRLAM data, respectively. The roses were computed using only observations that are present in both data sets. Comparing the two figures, discrepancies between the data sets can be identified. The wind directions measured by the buoy are more or less aligned with the local coast line (NE/SW), whereas the HIRLAM data winds blow more predominantly from East or from the West.

Figure 2.10 shows the scatter plot between the HIRLAM and the corresponding buoy U_{10} observations. The majority of the data compares quite well with the measurements, there is some scatter between the two data sets, but no indication of systematic errors. We have therefore decided to apply no correction to the HIRLAM U_{10} data.

We have also decided to apply no correction to the HIRLAM θ_w data. The discrepancy in directions are relatively small and for wind speeds above 10 m/s there is a good match between θ_w of the two data sets.

3 Offshore mean wave climate

3.1 Offshore wave conditions

The ECMWF wave data for 1999-2005 were corrected as described in Chapter 2. We will now describe the offshore mean wave climate based on that data. For brevity, we will no longer mention that the Northeast and Southeast data are the *corrected* data, since this will always be the case.

Figures 3.1-3.3 depict the mean wave climate roses as described by the ECMWF Northeast, Southeast and Western data, respectively (note the difference in scale in Figure 3.3). The corresponding tables of frequency distributions are given in Appendix A.

In the Northeast location the mean wave climate is characterized by waves either from West/Southwest or from East/Southeast. Based on the mean wave direction, about 50% of the waves in a year come from the West quadrants and the other 50% from the East quadrants. The most severe storms are from the East.

The mean wave climate in the Southeast location is characterized by waves predominantly from West/Southwest (about 65% of the waves in a year), with the most severe storms being from the East. Waves at this location have generally a higher H_s than those in the Northeast location.

In the Western location the mean wave climate is characterized by waves predominantly from West/Southwest (about 74%). Waves as high as 4 m can occur from East or West.

From these climate descriptions we can conclude that the yearly offshore climate in this region is characterized by about 50% of waves from the West and about 25% from the East, and the rest by generally mixed seas with waves reaching Gibraltar from east and west simultaneously. This will generally lead to double peaked spectra with an eastern and a western component. Waves with peak periods longer than 10 s can come from both directions.

3.2 Offshore wind conditions

We have compared the U_{10} and θ_w time series in the different HIRLAM locations and concluded that variations in space are small with correlations between the data sets for different locations always above 0.9. We have therefore considered the wind fields to be spatially uniform in the region and defined a time series of winds by averaging across all locations (shown in Figure 2.1). This time series is referred to as the *averaged HIRLAM data.*

Figure 3.4 presents the wind rose of the averaged HIRLAM data from 1999 to 2005. The wind climate in the region is characterized by winds blowing predominantly from East or from

West. The higher wind speeds are associated with winds from eastern directions (Cf. Table A.4 in Appendix A).

4 Nearshore mean wave climate

4.1 Objective

On the basis of the offshore wave conditions presented in Chapter 3, the normal nearshore wave conditions at the project site have been determined. The conditions were derived for the situation with and without the presence of the proposed scheme to determine the impact of the scheme on the normal wave conditions.

4.2 Approach

The offshore wave climate presented in Chapter 3 has been transformed to the project site using the two-dimensional fully spectral state-of-the-art wave propagation model SWAN (Simulating WAves Nearshore; Booij et al, 1999). The SWAN model has been validated and verified successfully under a variety of field cases and is continually undergoing further development. It sets today's standard for nearshore wave modelling and accounts for the following processes:

- wave propagation in space: shoaling and refraction due to both variations in the bottom and current;
- wave growth due to wind input;
- transfer of energy within the spectrum by non-linear wave-wave interactions;
- dissipation by bottom friction, whitecapping and depth-induced breaking;
- blocking and reflections by opposing currents;
- interactions with structures: transmission, blockage and reflection.

SWAN has been released under public domain (http://fluidmechanics.tudelft.nl/swan) and is integrated in WL | Delft Hydraulics' Delft3D modelling package (Delft3D-WAVE module).

Version 40.41 of the SWAN model was used in this project, including all current service patches. This version was tested by WL | Delft Hydraulics and integrated in the Delft3D modelling package.

Model setup

Given the location of the analysed offshore data, a rather large domain was required for the wave modelling study. In order to obtain the best compromise between computational accuracy and efficiency, three grids with different resolution and coverage were used. Accordingly, the wave modelling was carried out in three stages corresponding to different domains:

Stage 1: *Overall-domain*
A coarse (250m x 250m) grid, covering the overall-domain was used to model the mean waves travelling and being locally generated from the deep water boundaries of the region

to the finite depth offshore of the considered coastline. The estimated normal wave conditions are used as offshore boundary conditions and the estimated normal winds as uniform forcing. We shall call an offshore mean wave conditions and its associated mean wind a *wave scenario*.

Stage 2: *50m-domain*
A local and rather detailed 50 m resolution grid is used for computing wave fields in the shallow water regions along the coastline. The model results of the overall-domain are used as boundary conditions and the estimated mean winds as uniform forcing.

Stage 3: *20m-domain*
Given the steepness of the foreshore in the region of the planned development, a quite detailed, 20 m resolution grid is used for modelling the water in the immediate vicinity of the scheme. The model results of the 50m-domain are used as boundary conditions and the estimated mean winds as uniform forcing.

The three domains are outlined in Figure 4.1. The overall-domain grid covers the region outlined in green, the 50m-domain grid the region outlined in blue and the 20m-domain grid the region outlined in red. The bathymetries associated with these grids are given in Figures 4.2-4.4.

Model bathymetry

The bathymetry used in the wave modelling studies was constructed using different sources of bathymetric data. These sources can be divided into four groups:

Group 1
Survey data provided by the client (EBG). These data are the most up-to-date and the samples have the best resolution of all available sources. The data files in this group are summarized in Table 3.1.

Survey data file	Area
2050_3150_50	0.7 x 1.1 km^2
5350_7050_100	1.5 x 1.7 km^2
0_2000_20	1.3 x 2.0 km^2
10000_10010_10	2.5 km along the coast
spanje_0_950_50	0.6 x 1.0 km^2

Table 4.1 Surveys considered in Group 1

Group 2
Survey data from earlier studies of WL | Delft Hydraulics for this area. They consist of two sets of samples covering more or less the same area as the data in Group 1 and are also quite detailed.

Group 3

Digitized Admiralty Charts data. The considered charts were:

1st Map 144, Gibraltar (greater detail, smallest area);
2nd Map 1448, Gibraltar Bay;
3rd Map 142, Straight of Gibraltar;
4th Map 773, Straight of Gibraltar to Isla De Alboran (less detail, largest area).

Group 4

GEBCO (National Geophysical Data Centre) data.

All these data were converted to the vertical reference level OD (ordnance data) and the x,y-coordinates were converted to the UTM zone 30 projection with the ED50 datum.

The bathymetry was defined in four stages. In a first stage the data from Group 1 were used. These data cover an area which roughly extends from the south tip of Gibraltar to 1 km beyond the Spanish border and stretches out 1.5 km seaward. In a second stage, Group 2 data were used to fill up any gaps left by the data of Group 1. Next, the digitalized Admiralty charts data were used in the sequence given above. Finally, for the areas that were not covered by the data from groups 1 to 3 depth information from the in-house GEBCO database was used. The GEBCO data are rather coarse (with a resolution of about 1.5 km), but since they are used only for the very deep regions (with a depth of 300m or more) their accuracy does not affect the quality of the wave modelling study.

Model parameters

The SWAN model was run in third generation mode using the default settings. All computations were carried out at MSL (+0.427 m OD) and without currents.

Two sets of 20-m detail computation were carried out: with and without the proposed scheme. The proposed layout was modelled as an obstacle with a zero transmission coefficient. Wave reflection and diffraction by the scheme were not accounted for. Neglecting these effects may lead to a local underestimation of the waves in the areas close to the scheme. In our experience this underestimation is very small for sea states with directional spreading values similar to those considered in this study and limited to the sheltered areas immediately at the transition between the proposed layout and the beach.

Wave boundary conditions

In order to get a good representation of the mean wave climate a number of wave scenarios were defined. For each of the wave scenarios a mean wave condition was defined from the Western, Northeast and Southeast wave data and a mean wind condition from the averaged HIRLAM data. The mean wave conditions determined by the Southeast data were applied to the southern and the south third of the eastern overall-domain boundary, those determined by the Northeast data applied in the remaining two-thirds of the eastern overall-domain boundary, and those determined by the Western data were applied to the western overall-domain boundary. The wave boundary conditions were given parametrically and the wave parameters used were H_s, T_p and MWD. The estimated mean wind values were applied uniformly and covering the whole domain.

The mean wave climate from the ECMWF Northeast data was determined over H_s classes of 0.5 m (except for the first class which incorporates all H_s below 0.75 m) and MWD classes of 15°, and for each mean wave climate condition (i.e. each H_s /MWD class) the averages of H_s, T_p and MWD were computed. The averages of H_s, T_p and MWD of the synchronous Southeast and Western data were also computed, and so were the averages of the synchronous U_{10} and θ_w averaged HIRLAM data. All these averages were used as input conditions for the SWAN computations as described in Section 4.4.

To recap, for each H_s /MWD class to which Northeast data belong to, each normal climate condition, the average Northeast (H_s, T_p and MWD) and corresponding Southeast (H_s, T_p and MWD), Western (H_s, T_p and MWD), and wind data are computed. A wave climate scenario is therefore defined for each Northeast normal climate condition. Figure 4.5 shows 4 examples of such scenarios. The conditions associated with each scenario are listed in Table 4.2.

The percentage of occurrence per year of each wave scenario is determined using the Northeast data. From the derived wave scenarios only wave scenarios in which waves propagate towards the coast were considered, i.e. waves moving offshore (waves from North) were not taken into account. The total number of resulting wave scenarios was 66, which represent 98% of the year. For each of these scenarios the SWAN computations were carried out and the mean wave climate was computed along the coast of the development site combining the SWAN results with the associated percentage of occurrence of each scenario.

Scenario	Boundary wave conditions									Wind Condition	
	Northeast			Southeast			West				
	H_s (m)	T_p (s)	*MWD* (*° N*)	H_s (m)	T_p (s)	*MWD* (*° N*)	H_s (m)	T_p (s)	*MWD* (*° N*)	U_{10} (m/s)	θ_w (° N)
1	0.30	8.18	62.3	0.65	10.84	293.8	0.65	11.36	289.9	3.99	320.1
2	0.27	6.39	75.8	0.52	9.82	305.4	0.55	10.41	292.9	3.57	357.2
3	0.28	4.80	88.2	0.47	9.03	314.4	0.55	10.05	292.9	3.40	95.7
4	0.53	4.80	108.5	0.78	7.03	117.9	0.79	8.86	9.6	4.48	88.7
5	0.51	5.27	119.6	0.72	7.59	94.3	0.70	9.04	336.2	4.06	90.7
6	0.47	5.97	135.2	0.68	8.26	2.4	0.63	9.18	320.4	3.87	75.3
7	0.43	6.49	146.8	0.71	9.43	332.2	0.67	9.86	306.6	4.29	288.5
8	0.44	7.74	164.3	0.89	10.25	293.9	0.88	10.73	289.4	4.47	297.5
9	0.42	7.35	182.8	0.69	9.12	321.3	0.66	9.84	301.0	4.10	301.6
10	0.44	9.89	197.7	1.25	11.83	276.6	1.35	12.61	279.2	5.03	283.8
11	0.50	5.47	214.3	0.97	7.76	273.8	0.87	9.72	280.1	5.47	274.1
12	0.52	5.02	225.9	0.97	6.98	272.1	0.83	9.31	279.2	5.67	272.3
13	0.47	5.54	237.2	0.93	8.01	274.3	0.85	9.80	280.1	5.20	277.2
14	0.31	8.14	258.0	0.85	10.82	279.1	0.91	11.28	281.6	4.30	288.2
15	0.40	6.15	267.6	0.76	10.52	281.9	0.75	10.84	283.6	5.99	286.0
16	0.42	5.35	284.3	0.74	10.89	283.5	0.71	11.20	284.5	6.58	291.8
17	0.79	7.28	62.0	0.98	5.49	54.8	0.48	9.90	18.2	5.13	33.5
18	0.89	10.28	73.6	1.16	10.62	29.1	0.95	11.66	349.9	6.22	356.8
19	1.17	5.91	93.4	1.48	6.61	87.1	1.24	6.98	85.7	6.97	90.9
20	0.94	5.44	108.3	1.26	6.40	119.4	1.11	7.44	73.5	6.42	86.5
21	0.91	5.88	118.9	1.18	6.91	124.9	1.02	7.68	64.2	5.52	86.9
22	0.86	7.14	134.7	1.07	8.01	114.9	0.92	8.54	40.4	4.21	96.7
23	0.90	7.22	148.5	1.13	8.48	53.0	0.95	9.53	15.3	5.31	75.6
24	0.93	6.14	165.7	1.23	8.72	284.1	1.02	10.29	281.0	7.56	279.6
25	0.91	8.80	181.6	1.28	10.47	341.6	1.23	11.09	314.3	5.28	102.6
26	0.99	5.22	197.1	1.45	9.21	272.1	1.37	11.12	276.3	7.65	259.0
27	0.98	5.46	214.9	1.47	6.58	271.6	1.11	8.77	278.6	7.88	270.2
28	0.99	5.38	226.0	1.46	6.72	268.1	1.13	8.62	275.7	7.48	266.6
29	1.03	5.37	236.6	1.52	7.03	268.2	1.24	8.72	274.8	7.70	268.0
30	1.14	5.18	255.8	1.63	7.64	274.5	1.33	9.24	279.8	8.65	273.5
31	1.05	4.23	268.3	1.30	7.21	281.0	1.07	8.67	283.0	9.54	281.0
32	1.04	4.30	283.6	1.23	8.00	286.8	1.07	8.64	286.5	10.16	288.2
33	1.41	9.62	78.3	1.79	9.70	70.8	1.16	11.56	329.9	4.18	112.5
34	1.46	6.36	93.4	1.79	6.76	83.4	1.37	7.23	84.1	7.95	92.1
35	1.49	5.83	100.4	1.97	6.50	90.1	1.61	6.95	86.9	8.51	89.7
36	1.43	5.29	116.9	2.15	10.23	262.3	1.83	10.23	261.5	7.85	109.4
37	1.26	11.17	137.0	2.24	14.86	266.1	1.96	14.86	263.9	9.40	79.0
38	1.30	9.23	152.6	1.94	9.23	261.8	1.76	9.23	250.0	7.40	275.4
39	1.30	5.21	160.8	1.52	5.30	222.3	1.11	6.30	250.2	4.04	263.2
40	1.65	11.17	190.9	2.08	11.17	259.5	2.58	11.17	254.8	7.36	248.6
41	1.26	3.91	212.4	1.62	4.31	238.0	1.28	6.30	249.3	10.80	223.6
42	1.38	8.39	226.4	1.54	5.02	266.5	0.99	4.31	261.0	7.76	260.6
43	1.51	6.74	243.3	2.05	8.62	263.6	2.15	9.80	266.4	9.30	248.5
44	1.47	5.97	253.2	2.03	7.92	270.7	1.84	8.86	274.4	9.97	269.2
45	1.44	5.13	268.3	1.77	7.33	279.4	1.53	8.50	281.1	11.36	281.4
46	1.32	4.82	279.7	1.68	7.43	285.1	1.54	7.64	286.9	10.80	291.2
47	2.08	12.90	77.3	2.34	12.90	72.8	1.60	12.90	73.6	2.13	293.4
48	2.02	6.97	93.3	2.34	7.27	86.0	1.71	7.66	84.8	9.45	91.0
49	1.99	6.45	100.0	2.49	6.88	92.5	1.87	7.26	88.3	9.68	90.1
50	2.03	6.93	242.5	2.79	9.00	258.8	2.79	9.46	260.7	11.94	247.1
51	1.80	6.02	255.1	2.50	6.57	270.5	2.00	6.93	276.7	13.91	271.9
52	2.47	7.26	93.5	2.84	7.41	86.6	2.02	7.44	87.5	11.27	90.4
53	2.46	6.95	100.2	2.99	7.05	92.1	2.19	8.32	89.2	11.19	93.7
54	2.43	6.07	117.0	3.09	11.17	216.2	2.85	11.17	246.0	8.83	86.7
55	2.43	7.68	239.5	3.34	10.22	254.7	3.30	11.19	256.2	10.88	242.3
56	2.88	12.28	82.1	3.63	10.32	75.2	2.11	12.28	78.9	2.00	122.3
57	2.99	7.84	93.0	3.64	7.95	86.8	2.35	7.75	89.0	11.72	94.7
58	2.89	7.26	99.7	3.56	7.33	92.2	2.51	8.13	93.9	12.43	97.2
59	2.97	6.30	115.3	3.72	11.17	192.1	3.18	11.17	242.2	7.90	142.8
60	3.59	8.29	92.9	4.21	8.29	85.7	2.40	8.12	92.1	12.42	90.1
61	3.55	7.63	98.0	4.24	7.63	90.5	2.37	6.30	93.5	10.50	82.4
62	3.31	7.63	240.5	4.04	8.39	255.8	3.31	9.23	260.9	12.78	279.6
63	4.12	8.34	91.9	4.57	8.35	85.3	2.85	8.33	86.7	14.89	88.7
64	4.42	8.75	93.9	5.22	8.75	87.4	3.04	8.57	90.6	14.27	90.8
65	4.91	9.23	93.6	6.09	9.24	87.5	3.41	9.41	89.7	15.76	89.8
66	5.92	9.23	94.1	6.31	9.23	89.0	4.18	9.23	90.1	20.86	85.4

Table 4.2 Considered wave climate scenarios

4.3 Baseline Conditions

Figures 4.6-4.9 present the overall-domain results for the four typical scenarios presented in Figure 4.5. Each of the scenarios chosen for illustration produces waves with different characteristics in the vicinity of East Gibraltar. Figures 4.10-4.13 shows the 20m-domain computed significant wave height without (top) and with (bottom) the proposed layout for the same scenarios.

The wave condition presented in Figures 4.6 and 4.10 (scenario 17, cf. Figure 4.5) is characterized by wind sea (locally generated waves) from Northeast covering the whole region. The waves are low with H_s below 1 m. Comparison of the two panels of Figure 4.10 shows that the proposed scheme tempers the nearshore waves in its immediate vicinity, but the area of influence is very limited.

Figure 4.7 shows a typical eastern storm in the area (scenario 34, cf. Figure 4.5). Waves travel undisturbed nearly perpendicular to the planned proposed layout. Comparison of the two panels in Figure 4.11 shows that there is some influence of the scheme in the immediate vicinity north and south of the proposed layout, but that the wave patterns are nearly identical at a distance of about 250 m north and south of the scheme. For this condition there is no effect north of the Spanish border.

Figure 4.8 shows a rather interesting wave condition since it depicts the occurrence of mixed seas in the region (scenario 36, cf. Figure 4.5) with long waves coming from West (Cf. Figure 4.5) and wind-sea from Southeast. In the development region the MWD is from Southeast but the wave spectra also contain a southern component. Figure 4.12 shows that again the influence of the proposed layout in the surrounding wave conditions is limited. At a distance of about 400 m to the north of the scheme, no significant differences can be noticed any more, which means that this condition also shows no effect near the Spanish border.

Our final example depicts western winds and western waves offshore (scenario 44, cf. Figure 4.5). The western waves moving from the Strait of Gibraltar rotate parallel to the shore, moving along the shore in the eastern Gibraltar coast (see Figure 4.9). The wave height of the waves moving along the development region is rather small compared to the waves offshore. The scheme blocks some of the waves moving north and reduces the fetch of the waves being locally generated by the western wind resulting in a small decrease of the wave heights east of the scheme (Cf Figure 4.13).

4.4 Impacts of the proposed scheme

Figure 4.14 depicts the mean wave climate at the northeast offshore boundary of the overall-domain and the computed mean wave climate at a location close to the development site at the 10 m OD depth line (the corresponding H_s/MWD and H_s/T_p frequency tables are given in Appendix A). From the nearshore wave rose we conclude that the most predominant and higher waves nearshore come from East/Southeast. Another important wave direction is from South/Southeast (waves coming from the Strait of Gibraltar).

Figures 4.15 and 4.16 present the mean wave climate for five locations at the 8 m OD depth line in the area of the planned layout computed without and with the proposed scheme, respectively. We will refer to the locations considered as *location 1* to *location 5*, numbering from south to north. The corresponding tables of frequency distributions are given in Appendix A.

Comparing figures 4.15 and 4.16 and tables A.6 to A.15 we note that:

- In the most northerly location (location 5, about 600 m north of the proposed layout) the wave roses show no effect of the scheme on waves from all directions.
- Immediately north of the planned scheme (location 4) only waves from southerly directions are influenced, but only to a very limited extent. Tables A.9a and A.14a show that the occurrence of direction 150°N increases about 2%, whereas the occurrence of more southerly directions decreases, due to a little shift in direction in a few scenarios., It can also be seen that the occurrence of significant wave heights smaller than 0.25 increases about 0.7% due to a reduction of occurrence in the next wave height class.
- In the location to the east of the planned development (location 3) there is no visible effect of the scheme on waves from easterly directions. For the south/south-easterly waves there is a small reduction in wave height (shift of about 0.8% from the second to the lowest wave height class, see Table A.8a and A.13a) and a shift to slightly more easterly directions (occurrence of 120°N and 150°N 0.8% resp. 1.5% higher, while more southerly directions are less frequent). Furthermore the waves from westerly directions disappear completely from the wave rose.
- Immediately to the south of the planned scheme (location 2) there is no effect worth mentioning.
- The same conclusion goes for the most southerly rose (location 1). This wave rose shows a slightly higher occurrence in the lowest wave class (H_s < 0.25m), but closer investigation of the results showed that this is due to some wave scenarios that for both situations have a nearshore significant wave height just on the class limit of 0.25 m.

In conclusion, beyond a distance of about 500m to the north and about 200m to the south of the proposed scheme, the effect of the proposed layout on the normal wave conditions is negligible.

Assuming that the sand for the landfill of the scheme will be dredged uniformly in the borrow areas, the impact of the borrow areas is predicted to be negligible—changes of less than 0.1% in the occurrences presented in tables A.11-A.14. This because the changes in water depth and slope will be relatively small. The wave field surrounding the borrow areas can however be affected, if dredging is done unevenly creating, for instance, a deep channel or pit.

4.5 In-combination effects

4.5.1 Introduction

In this study "in-combination effects" are the effects of other developments than the planned development at the 'Rubble Tip'. In this section the coastal impact of the planned development in combination with the ”Both Worlds” project (planned south of Sandy Bay, see Figure 1.3) is discussed. At present, no other future developments are known.

4.5.2 Both Worlds Project

A small extension of the rocky outcrop just south of Sandy Bay is planned (“Both Worlds” Project, see Figure 1.3). The impact of this project is evaluated on the basis of expert judgement.

Considering the small scale of the Both Worlds Project at Sandy Bay, the impact of the Both Worlds Project on the normal wave climate will be very small and limited to a small part of Sandy Bay only. It can therefore be concluded that the Both Worlds project will not introduce any additional effects on the normal wave climate along the east coast, nor on the borrow areas. No cumulative effects are expected as a result of the combined proposed scheme and Both Worlds Project developments. Furthermore, no effect of Eastside Gibraltar on the Both Worlds Project area is expected.

4.6 Transboundary effects

As stated above, the planned works will only affect the normal wave conditions in a region extending about 500 m north and 200 m south of the proposed scheme, with the magnitude of the changes in conditions decreasing with the distance from the scheme. This means that the proposed layout will not influence the wave climate into Spanish waters.

5 Conclusions

In this study we have made use of the best quality wave, wind and bathymetry data available and the best state-of-the-art, shallow water wave model with the objective of defining the present wave conditions along the coast at the project site. Additionally, we have studied the influence of the proposed development on the surrounding wave climate.

The wave climate along the coast of the projected site was found to be characterized by waves most frequently from East/Southeast. This is also the direction of the highest waves in the region. There are also frequent waves from the south in the region, but these are rather low. Given these characteristics of the mean wave climate in the region and the layout of the planned scheme, its influence in the mean wave climate is limited to a small region around the scheme, extending about 500 m north and 200 m south of the scheme.

In the evaluation of the impact of the borrow areas it has been assumed that there will be uniform dredging (i.e. not uneven, consistent depth across the area, no deep channel or pit). It is recommended to include this aspect in the dredging specifications to agree with the provided modelling results.

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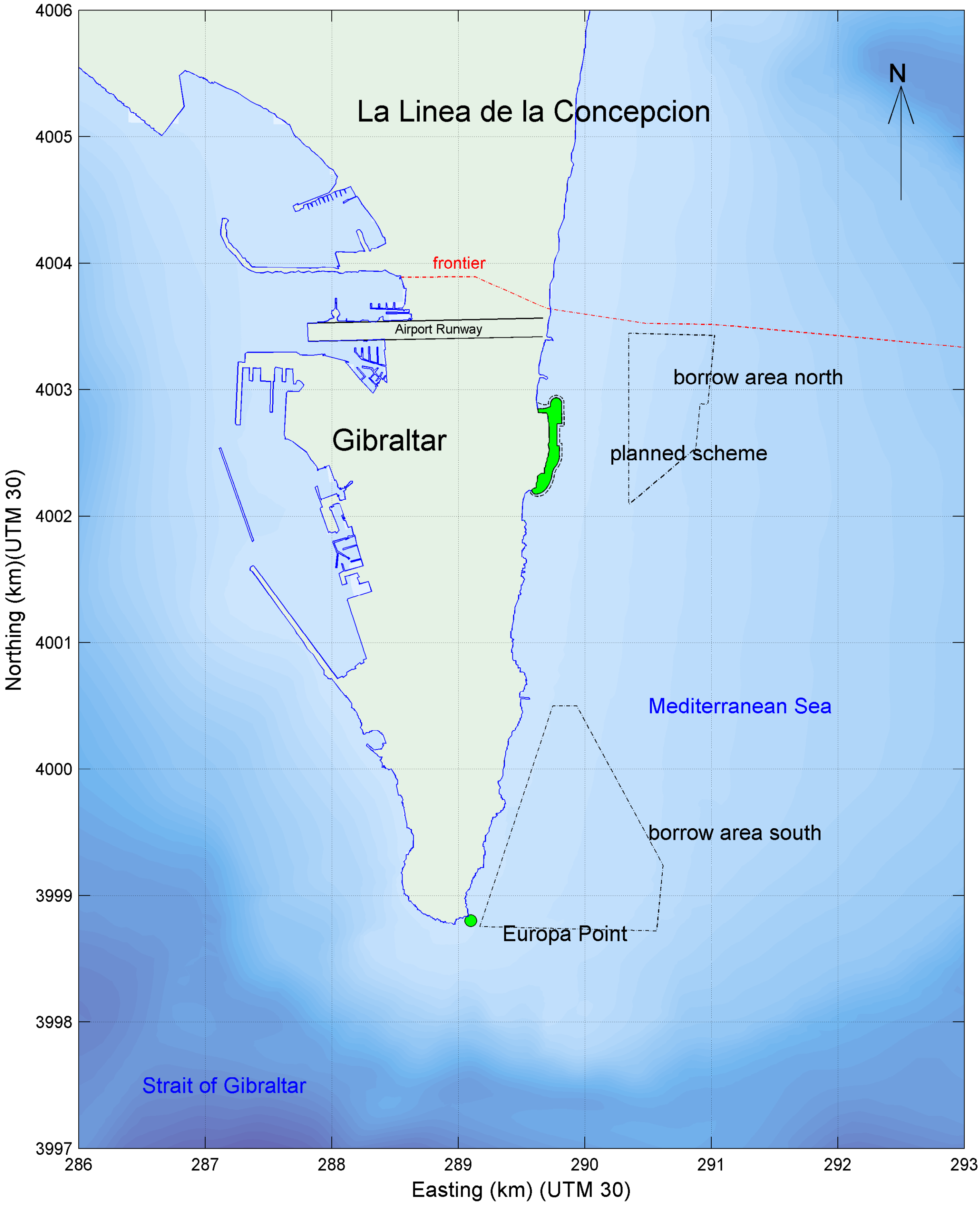
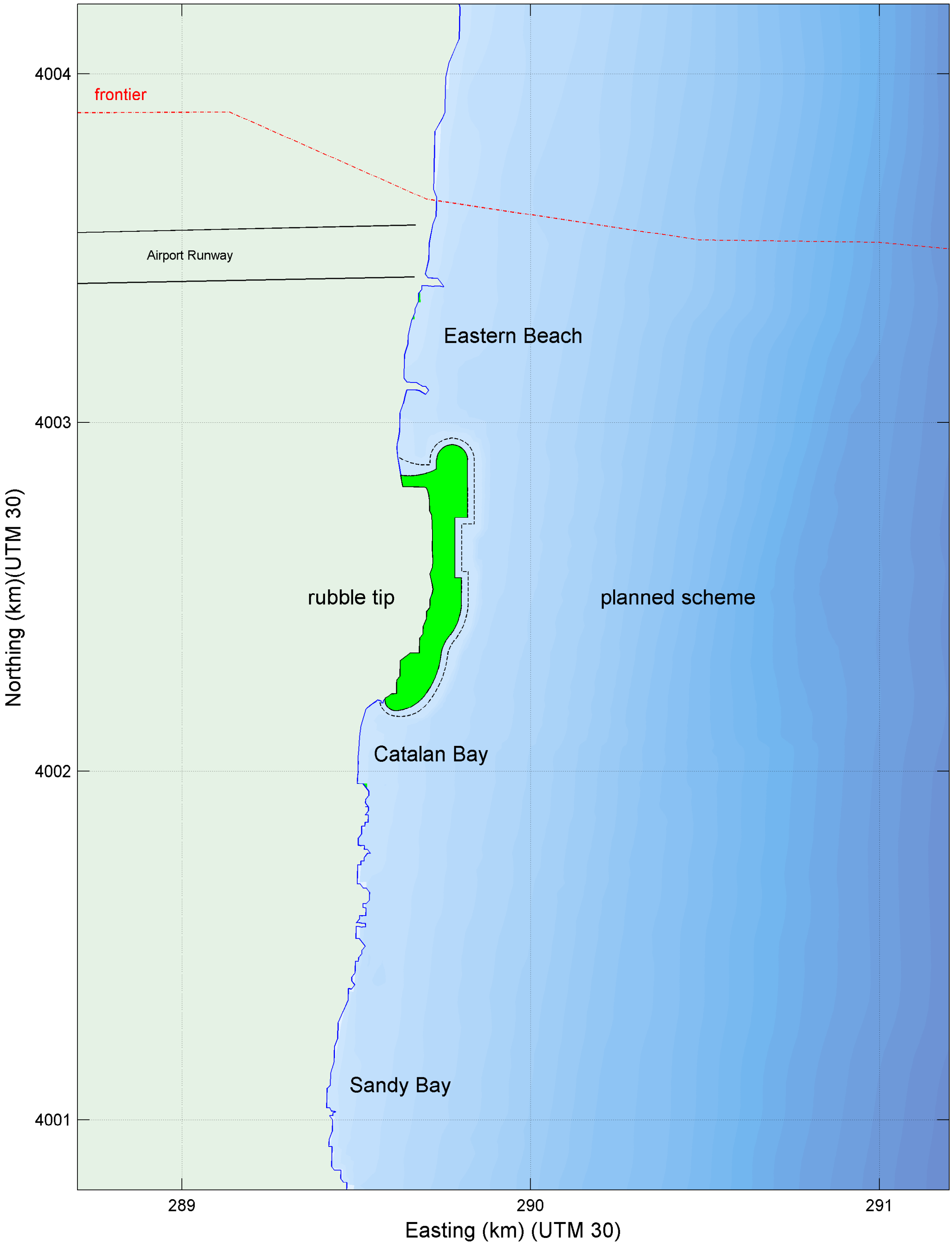
Figures



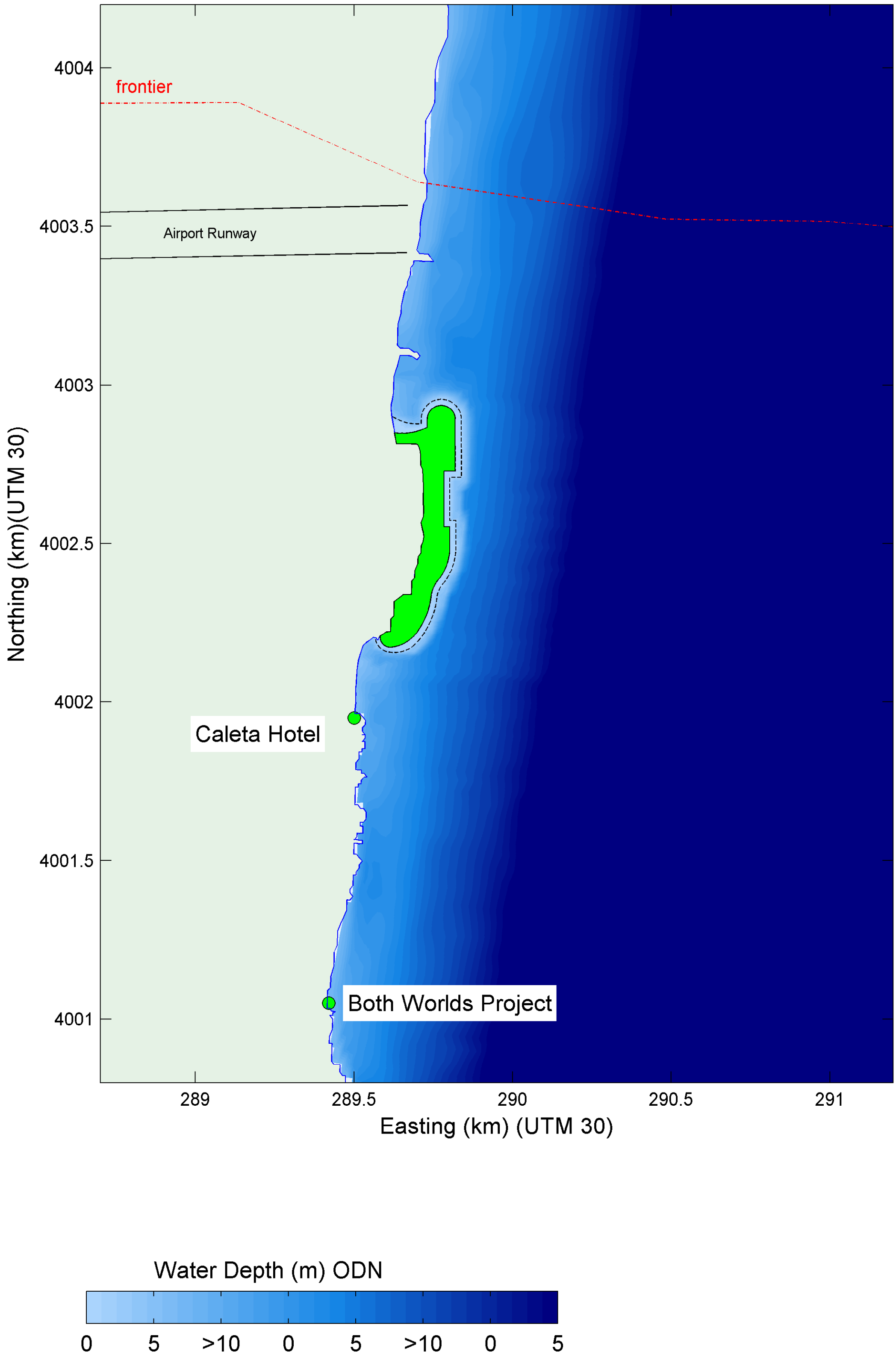
Eastside, Gibraltar
Project location

WL | DELFT HYDRAULICS H4725 Fig. 1.1

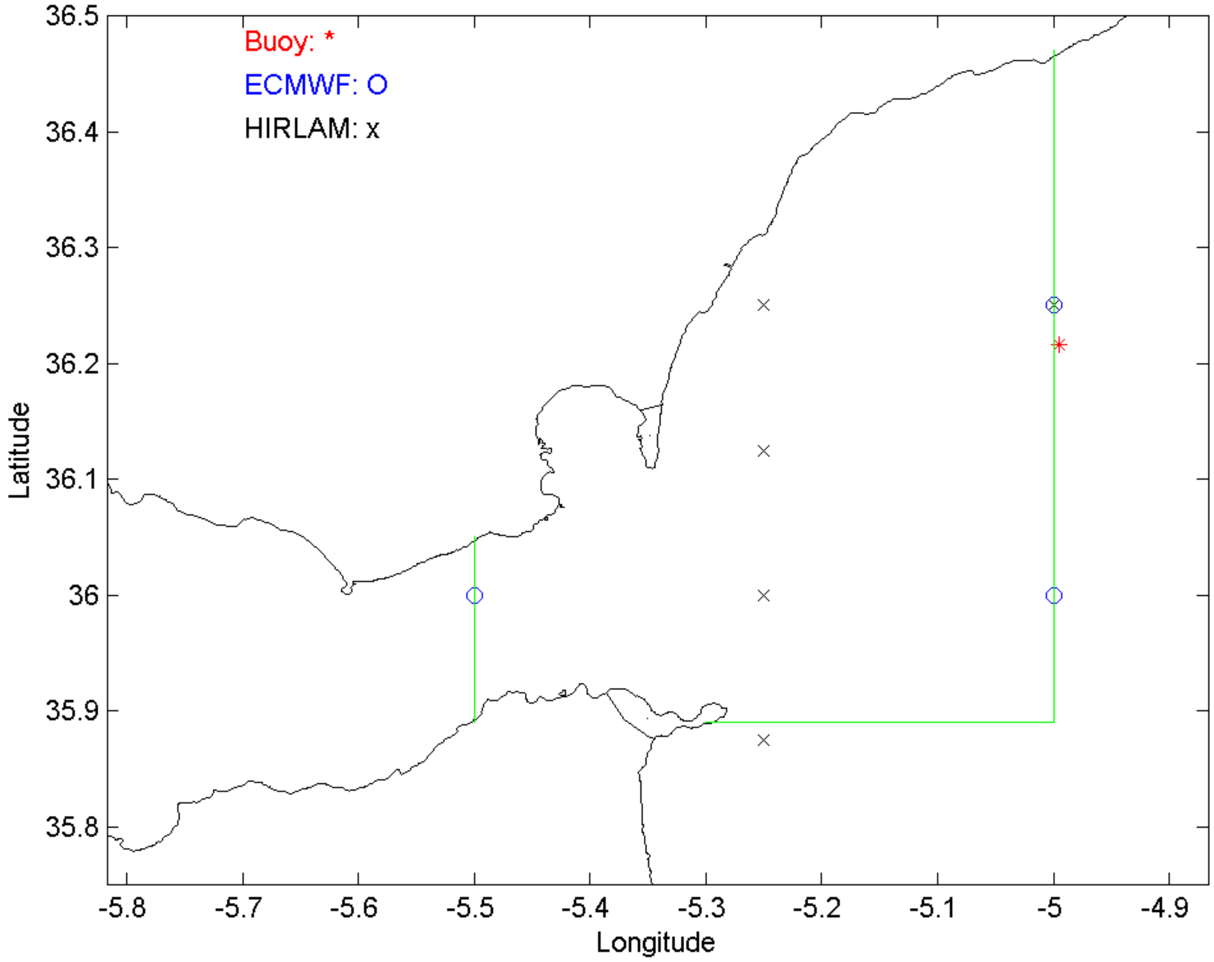


Eastside, Gibraltar
Project site : future situation with scheme

WL | DELFT HYDRAULICS	H4725	Fig. 1.2

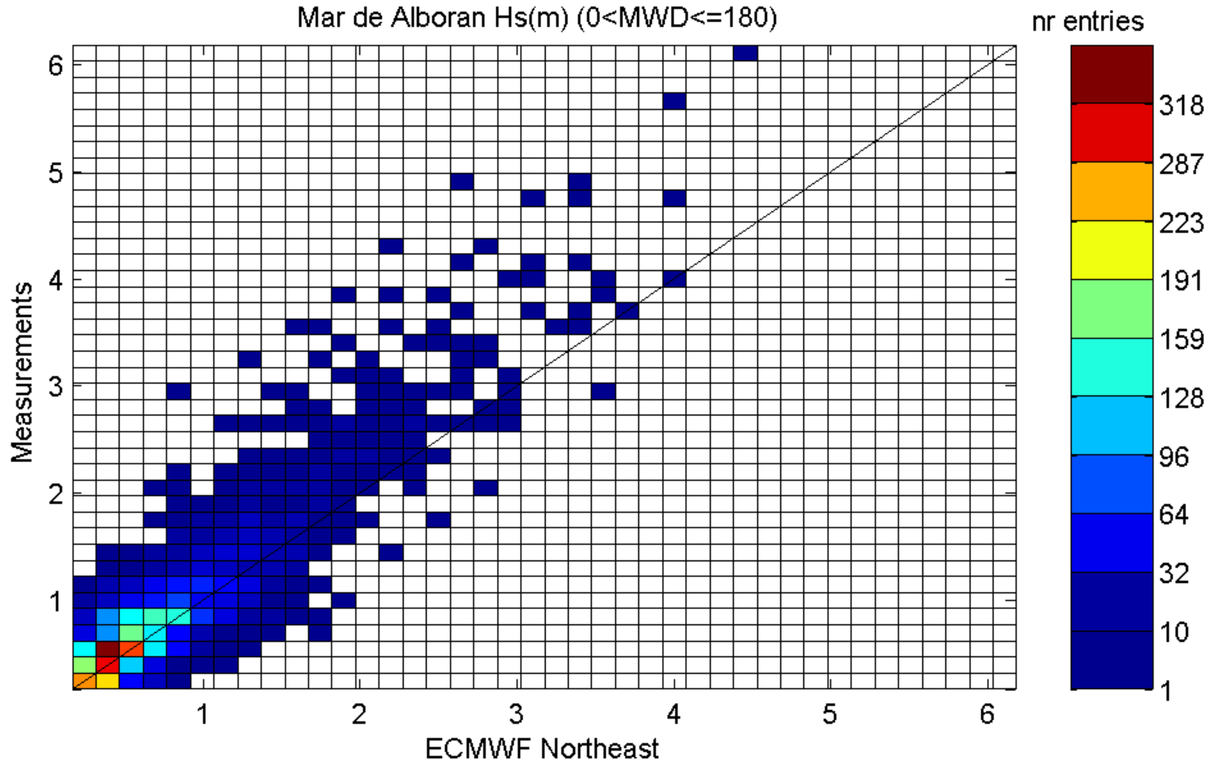


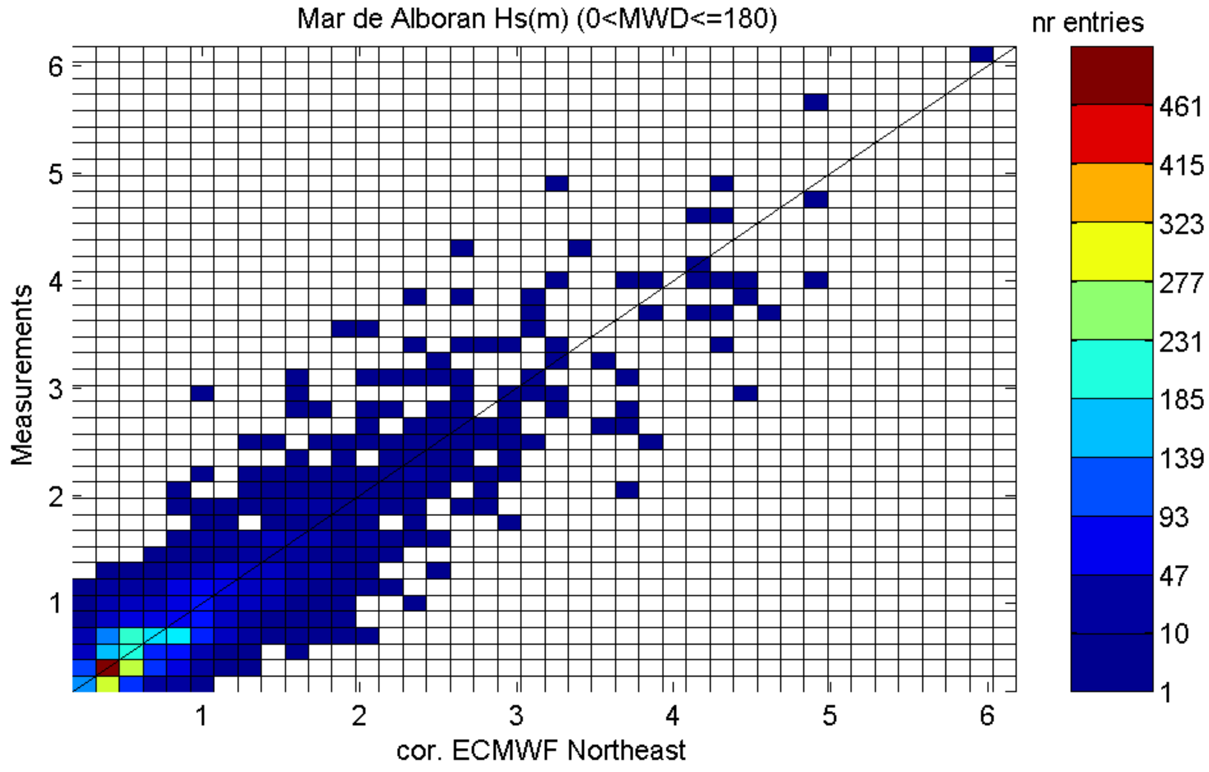
Development scheme in combination with Both Worlds Project		Delft3D
WL | DELFT HYDRAULICS	H4725	Fig. 1.3



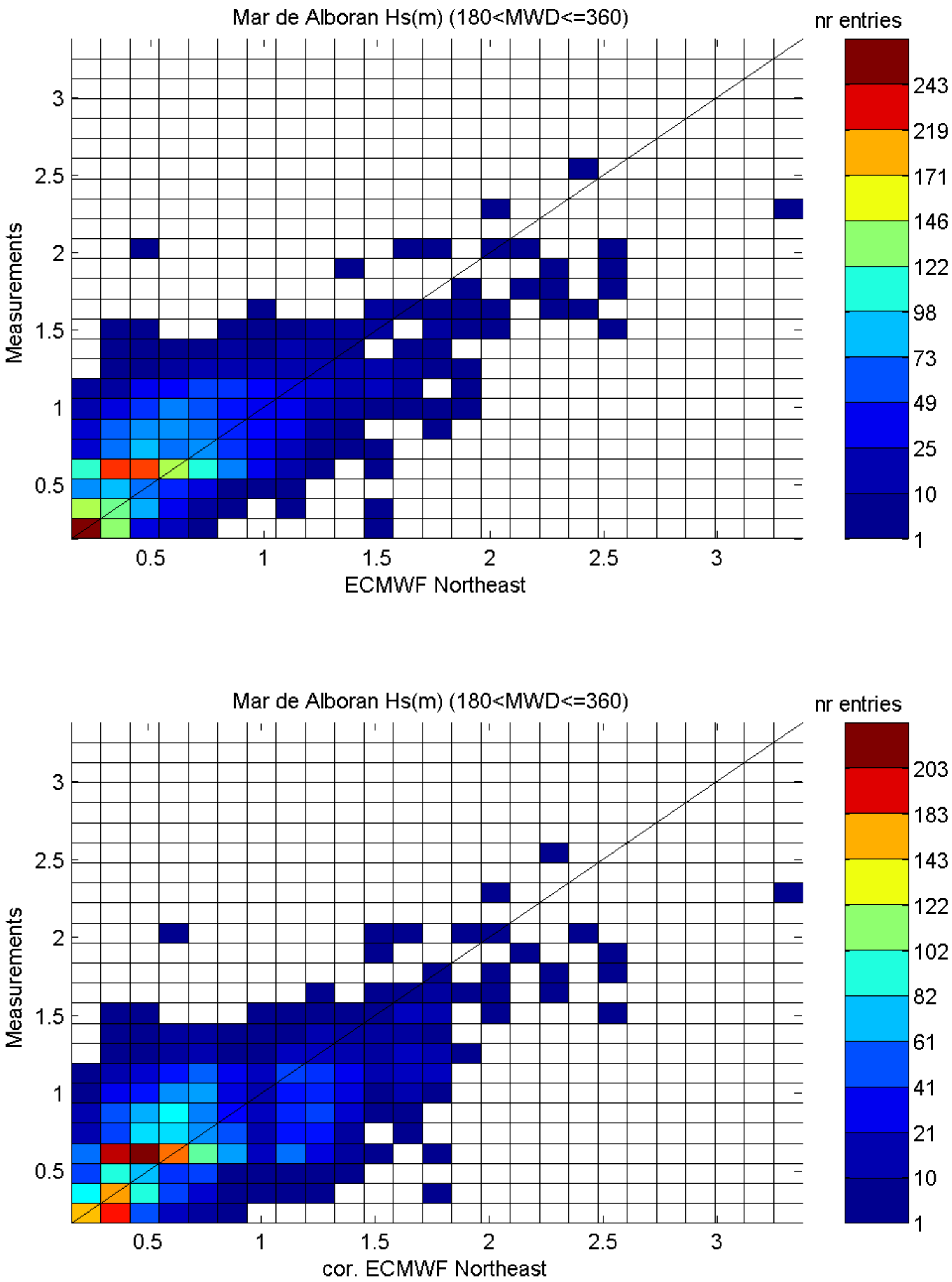
Overview of the data locations

WL | DELFT HYDRAULICS	H4725	Fig. 2.1

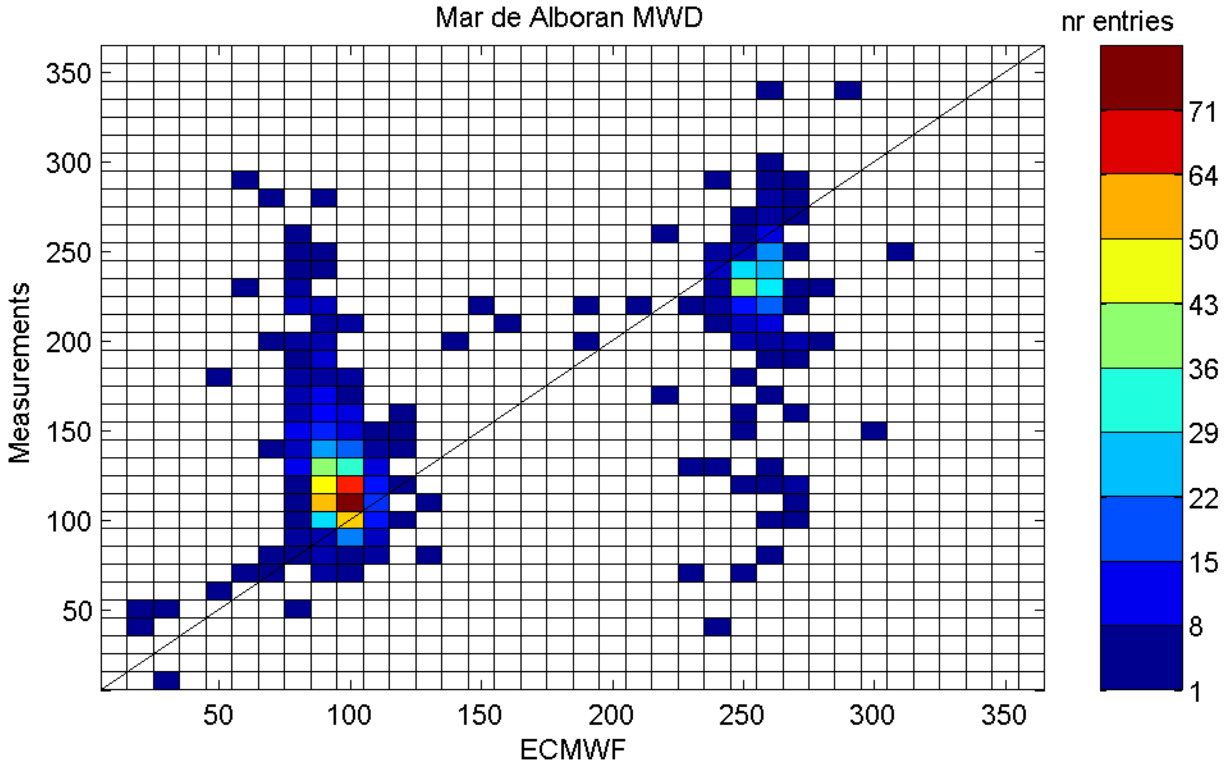


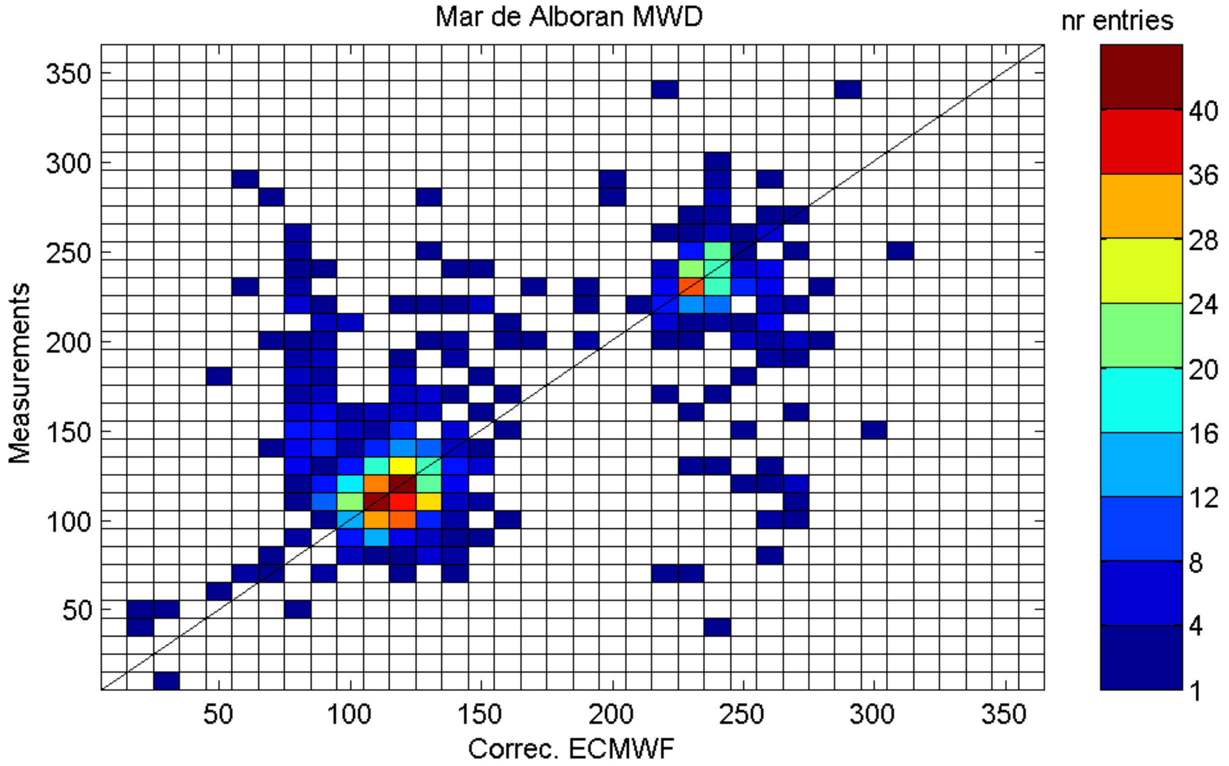


Scatter plots of original and corrected ECMWF data	0<MWD<=180	
WL | DELFT HYDRAULICS	H4725	Fig. 2.2



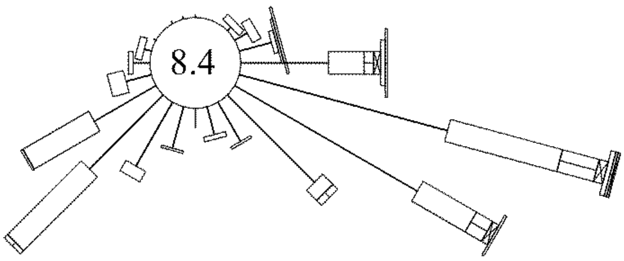
Scatter plots of original and corrected ECMWF data	180<MWD<=360	
WL | DELFT HYDRAULICS	H4725	Fig. 2.3

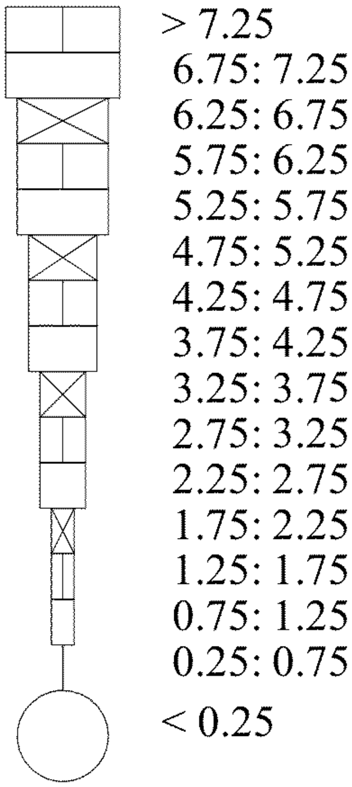




Scatter plots of original and corrected ECMWF data

WL | DELFT HYDRAULICS	H4725	Fig. 2.4





Significant wave height (m)

EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

20.0 %

Wave height rose Mar de Alboran
measurements (all)

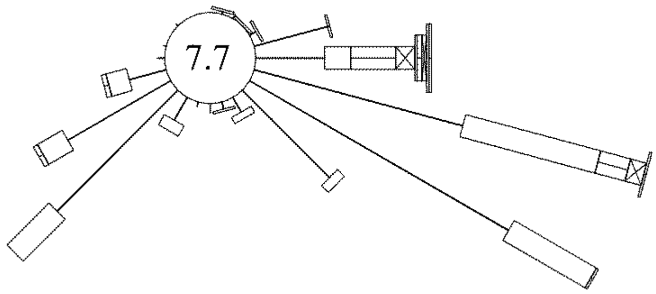
Sea + Swell

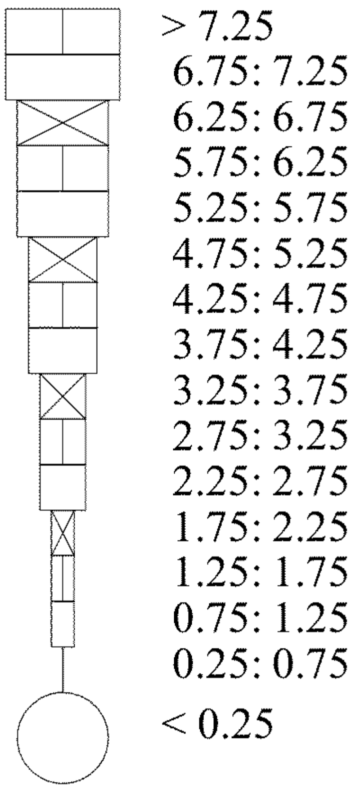
All Year

WL | DELFT HYDRAULICS

H4725

FIG. 2.5





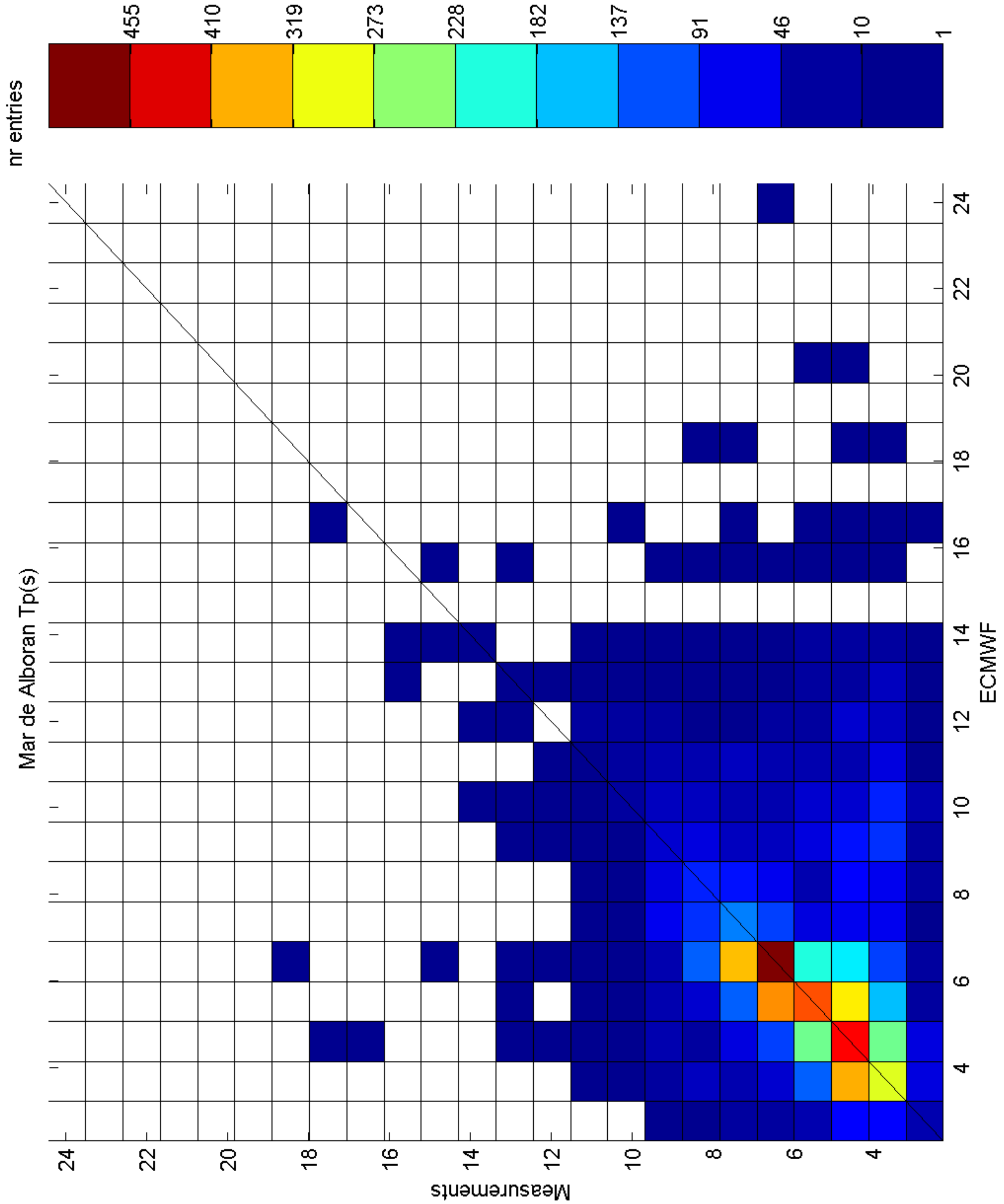
Significant wave height (m)

EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

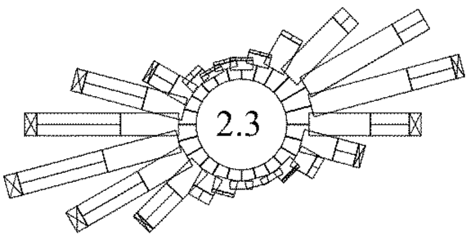
20.0 %

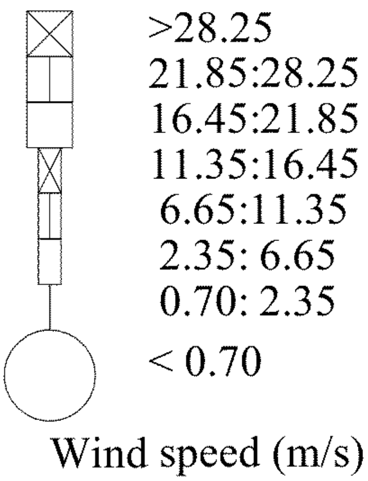
Wave height rose Northeast ECMWF gridpoint corrected data (only when meas. are avail.).	Sea + Swell All Year
WL | DELFT HYDRAULICS	H4725 FIG. 2.6



Scatter plots of the measurements and the ECMWF T_p data

WL | DELFT HYDRAULICS	H4725	Fig. 2.7





EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

20.0 %

Wind speed rose Mar de Alboran wind measurements (only when HIRLAM data is available)

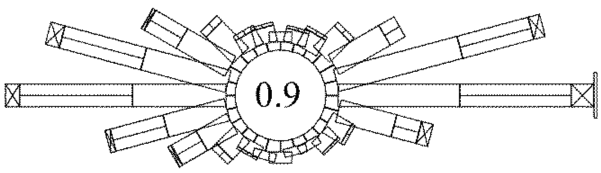
Wind

All Year

WL | DELFT HYDRAULICS

H4725

FIG. 2.8



>28.25
21.85:28.25
16.45:21.85
11.35:16.45
6.65:11.35
2.35: 6.65
0.70: 2.35
< 0.70

Wind speed (m/s)

EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

20.0 %

Wind speed rose HIRLAM data close to the buoy location (only when buoy meas. are available)

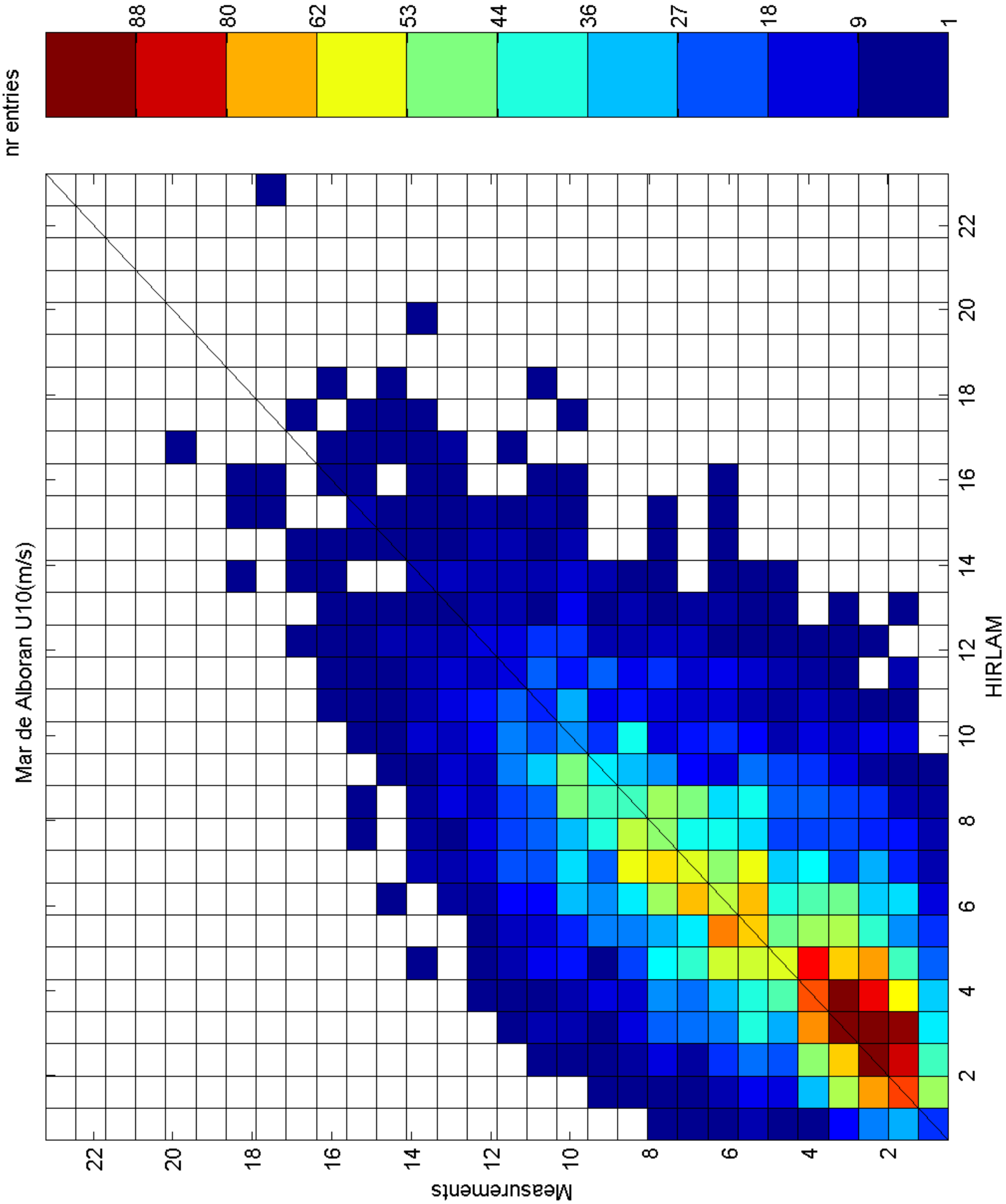
Wind

All Year

WL | DELFT HYDRAULICS

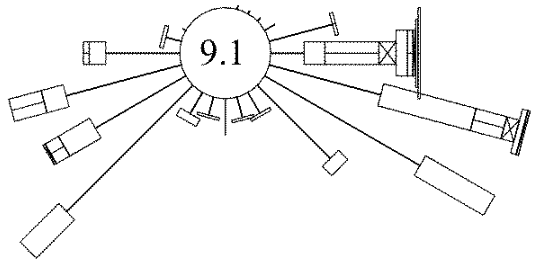
H4725

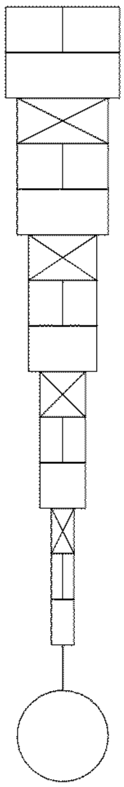
FIG. 2.9



Scatter plot of the wind speed data

WL | DELFT HYDRAULICS | H4725 | Fig. 2.10





EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

20.0 %

Wave height rose ECMWF Northeast corrected data (1999-2005)

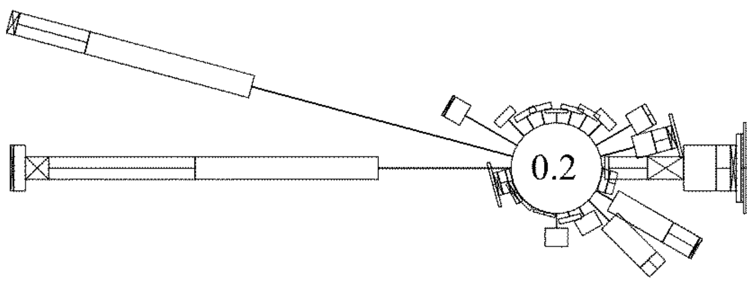
Sea + Swell

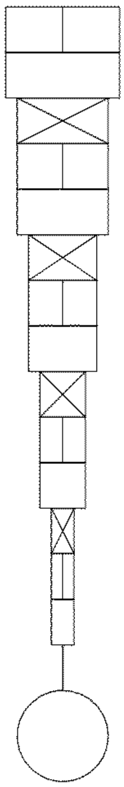
All Year

WL | DELFT HYDRAULICS

H4725

FIG. 3.1





> 7.25
6.75: 7.25
6.25: 6.75
5.75: 6.25
5.25: 5.75
4.75: 5.25
4.25: 4.75
3.75: 4.25
3.25: 3.75
2.75: 3.25
2.25: 2.75
1.75: 2.25
1.25: 1.75
0.75: 1.25
0.25: 0.75
< 0.25

Significant wave height (m)

EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

20.0 %

Wave height rose ECMWF Southeast corrected data (1999-2005)

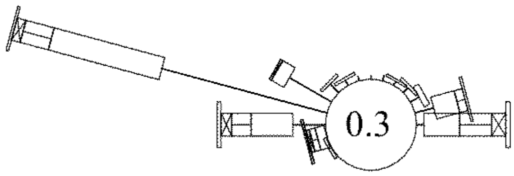
Sea + Swell

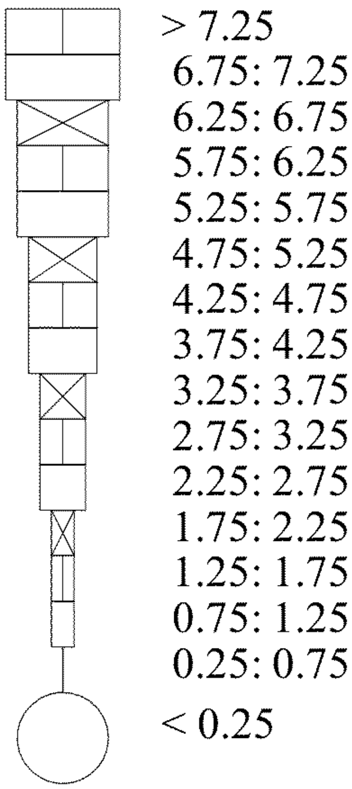
All Year

WL | DELFT HYDRAULICS

H4725

FIG. 3.2





Significant wave height (m)

EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

50.0 %

Wave height rose ECMWF Western data (1999-2005)

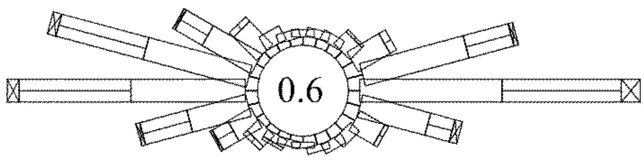
Sea + Swell

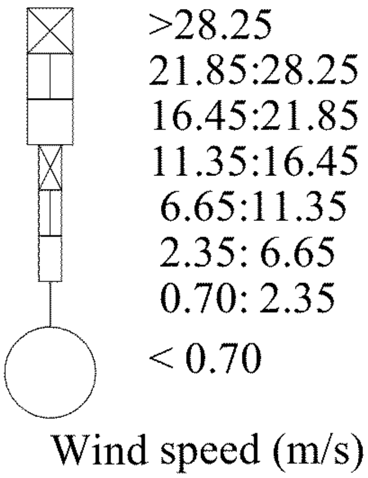
All Year

WL | DELFT HYDRAULICS

H4725

FIG. 3.3



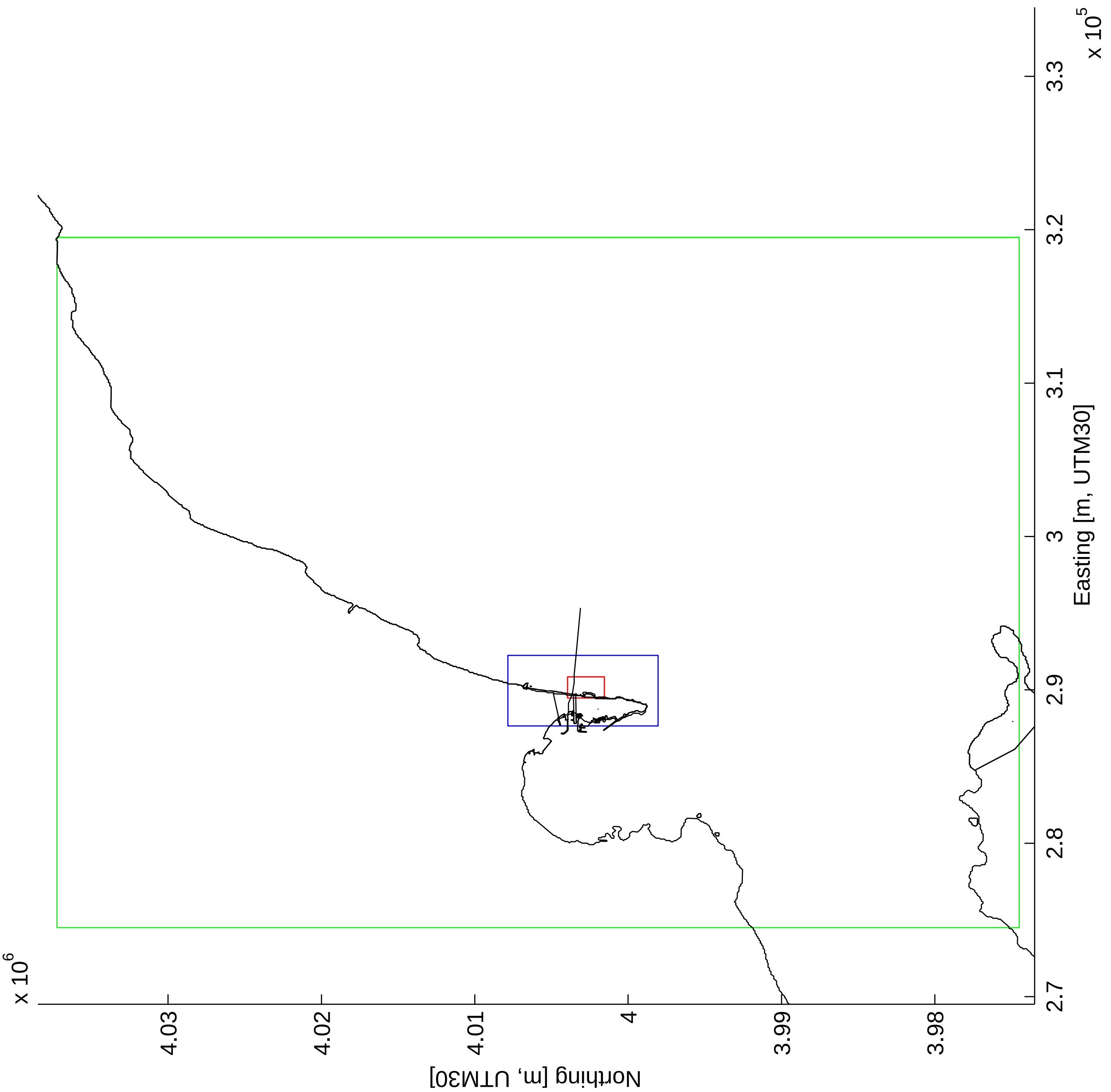


EXPLANATION

Item:	Represents:
Type of bar	Height / Speed
Direction of bar (to centre of rose)	Direction
Length of bar	Occurrence (%
Number in centre of rose	Occurrence (%) in lowest class

20.0 %

Wind speed rose Averaged Hirlam data (1999-2005)	Wind	
	All Year	
WL | DELFT HYDRAULICS	H4725	FIG. 3.4



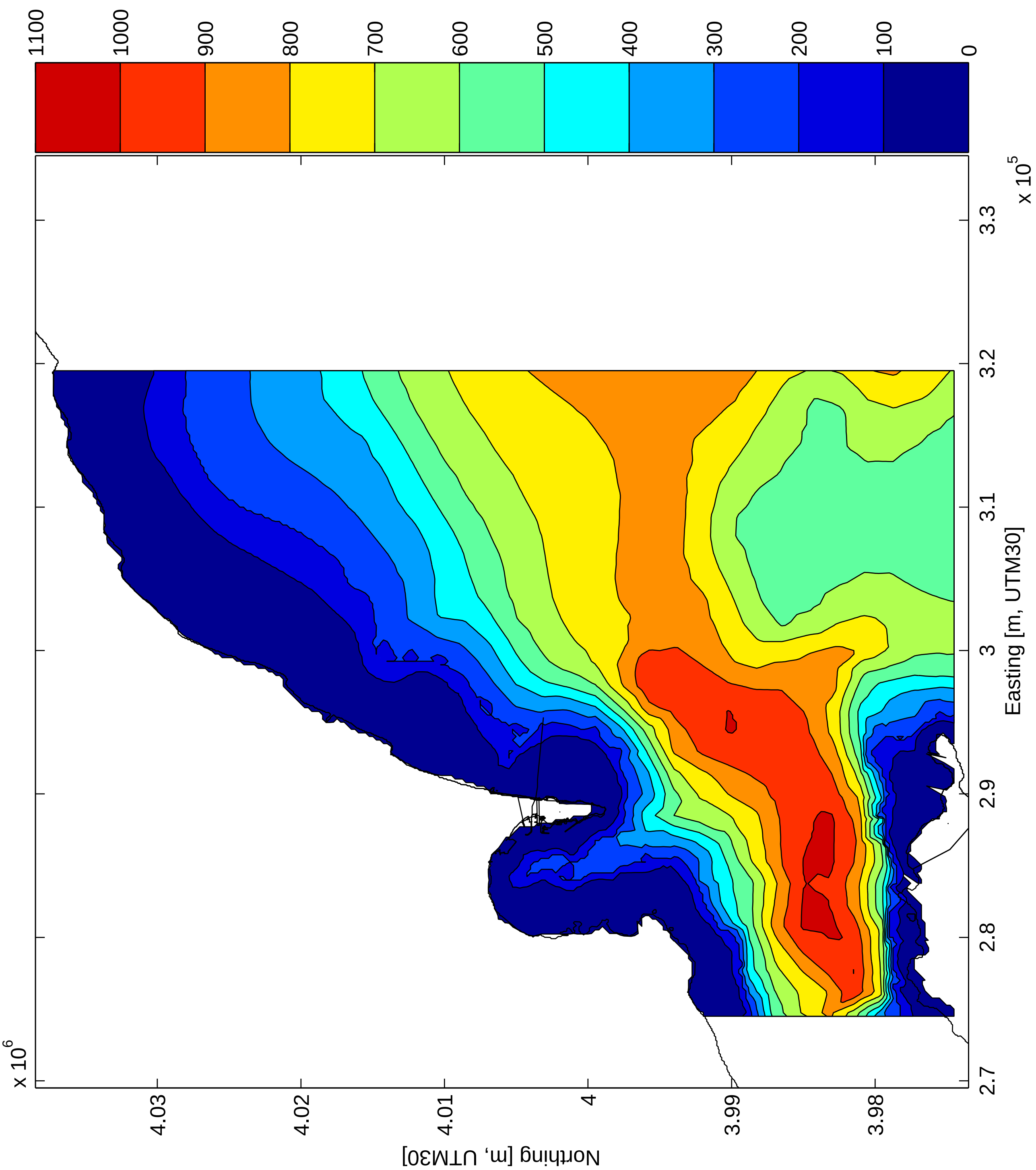
Wave modelling domains

Delft3D−WAVE

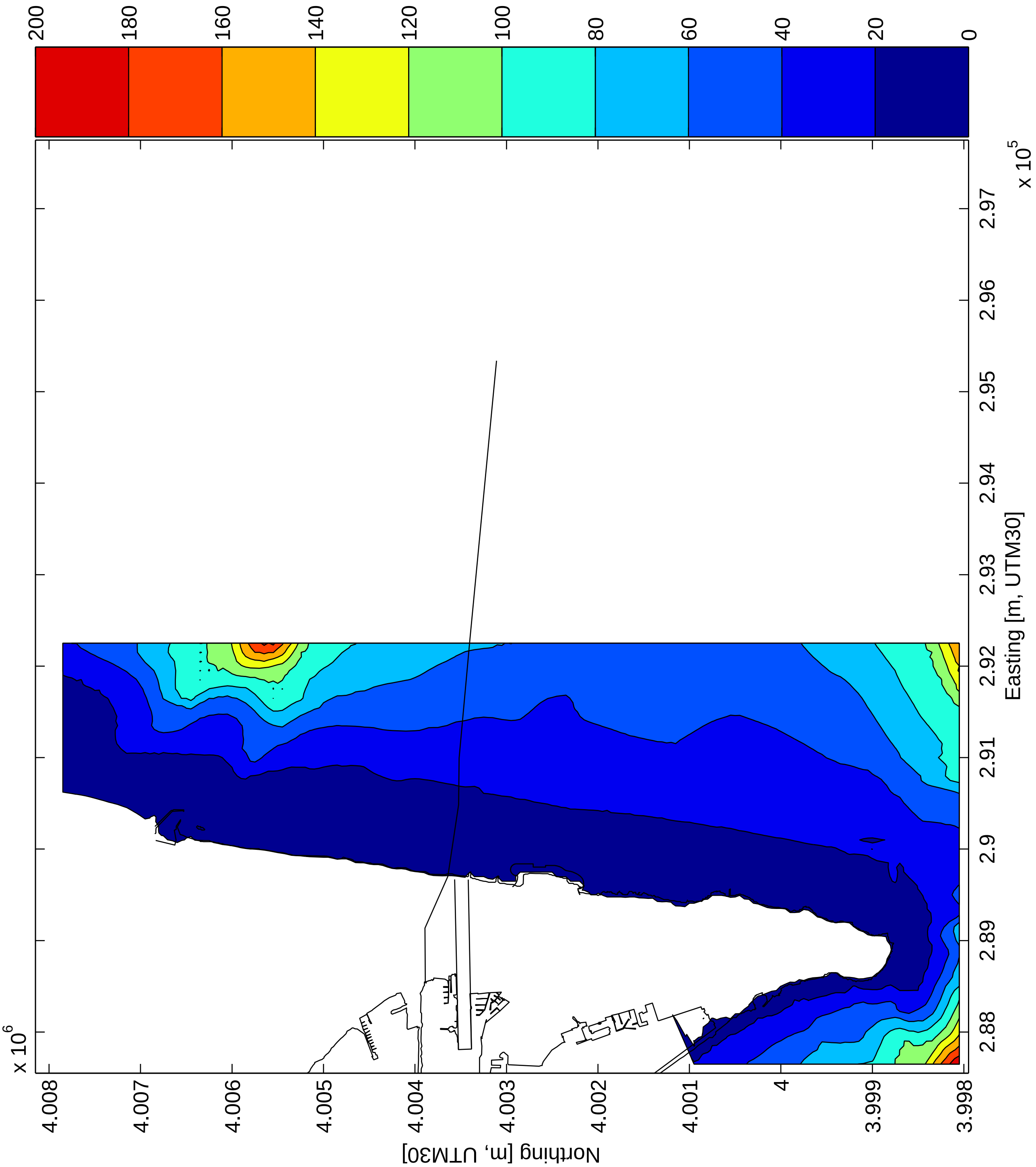
WL | DELFT HYDRAULICS

H4725

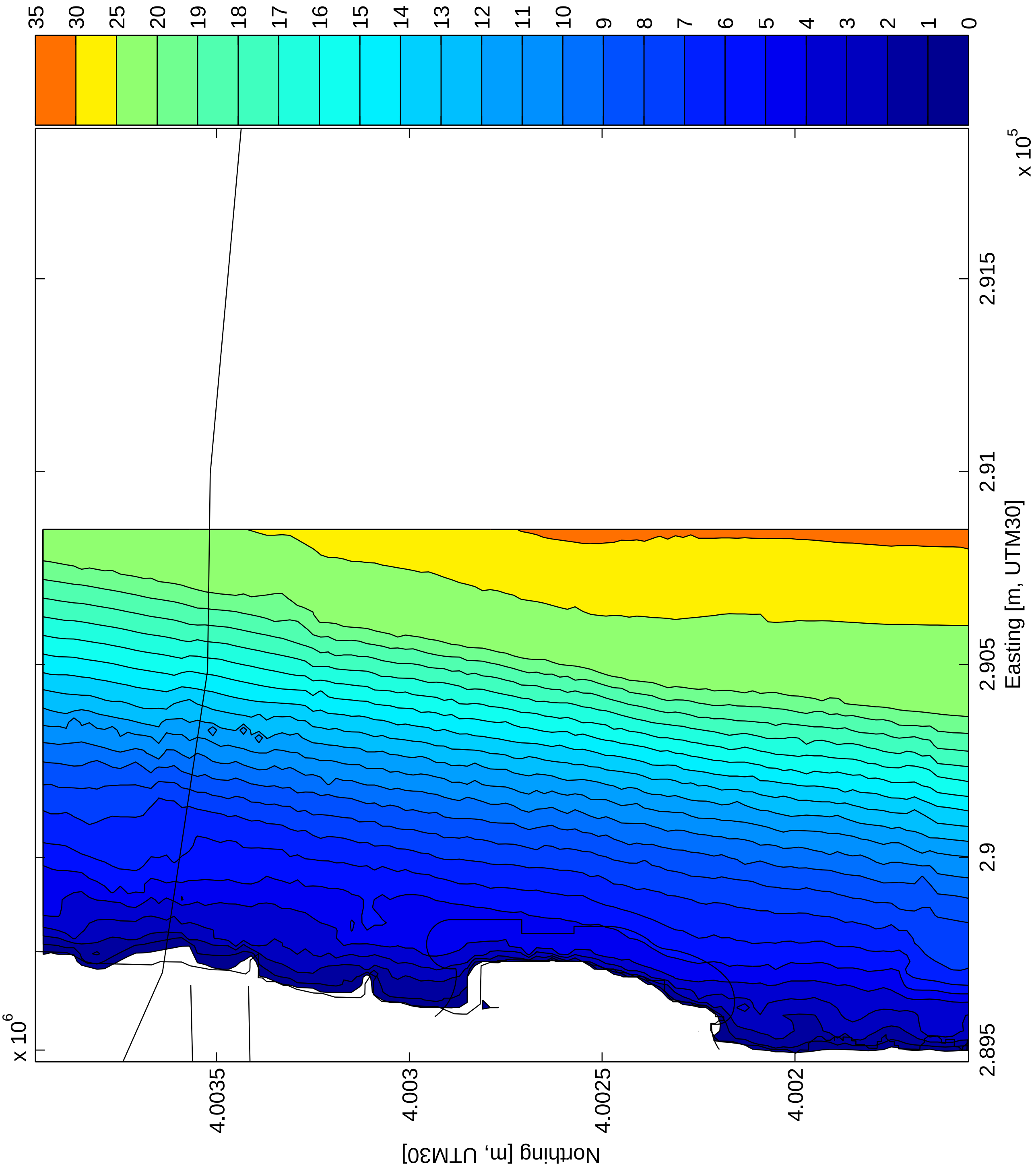
Fig. 4.1



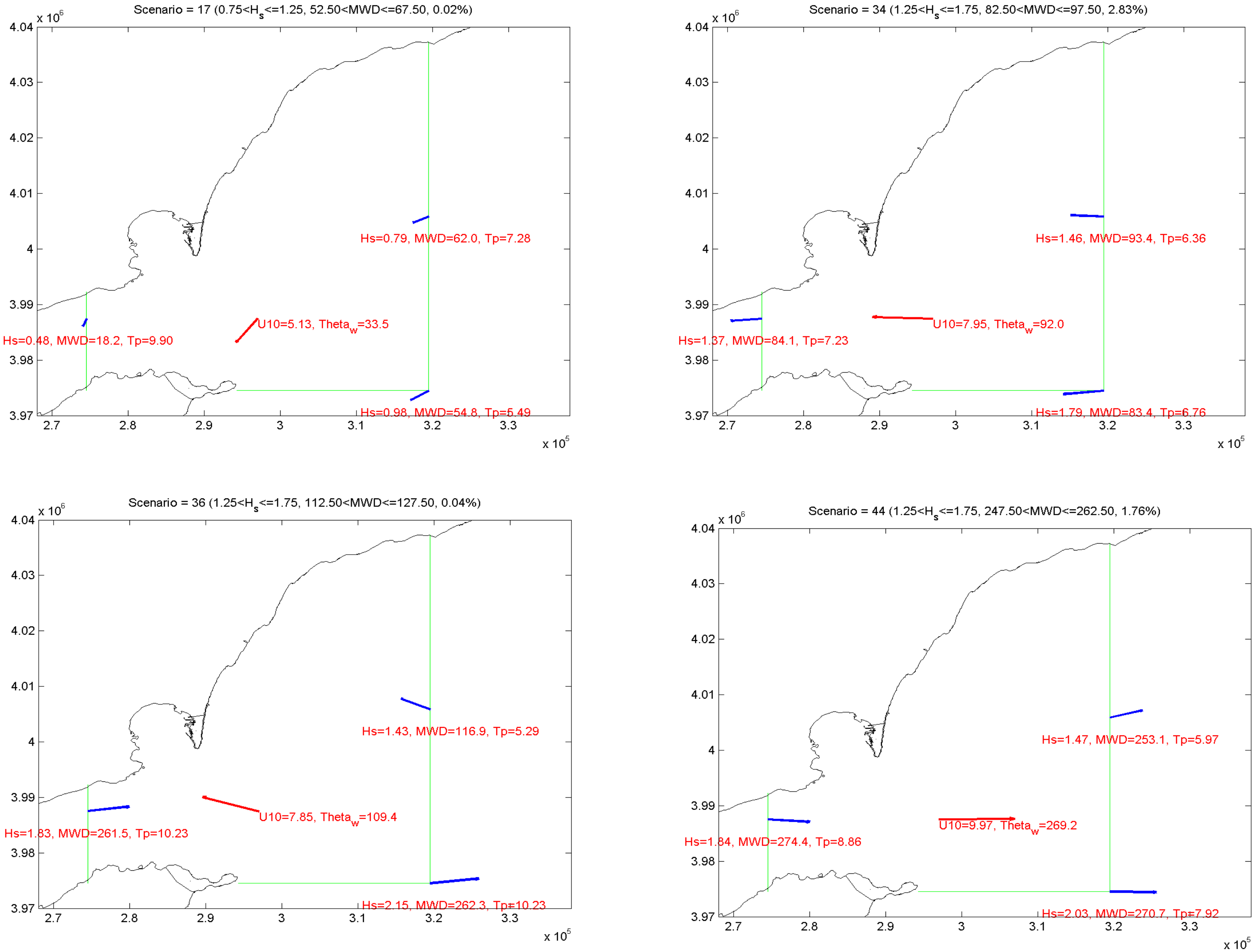
Overall−domain SWAN bathymetry	m OD	
	Delft3D−WAVE	
WL | DELFT HYDRAULICS	H4725	Fig. 4.2



50m−domain SWAN bathymetry	m OD	
	Delft3D−WAVE	
WL | DELFT HYDRAULICS	H4725	Fig. 4.3



20m−domain SWAN bathymetry	m OD	
	Delft3D−WAVE	
WL | DELFT HYDRAULICS	H4725	Fig. 4.4

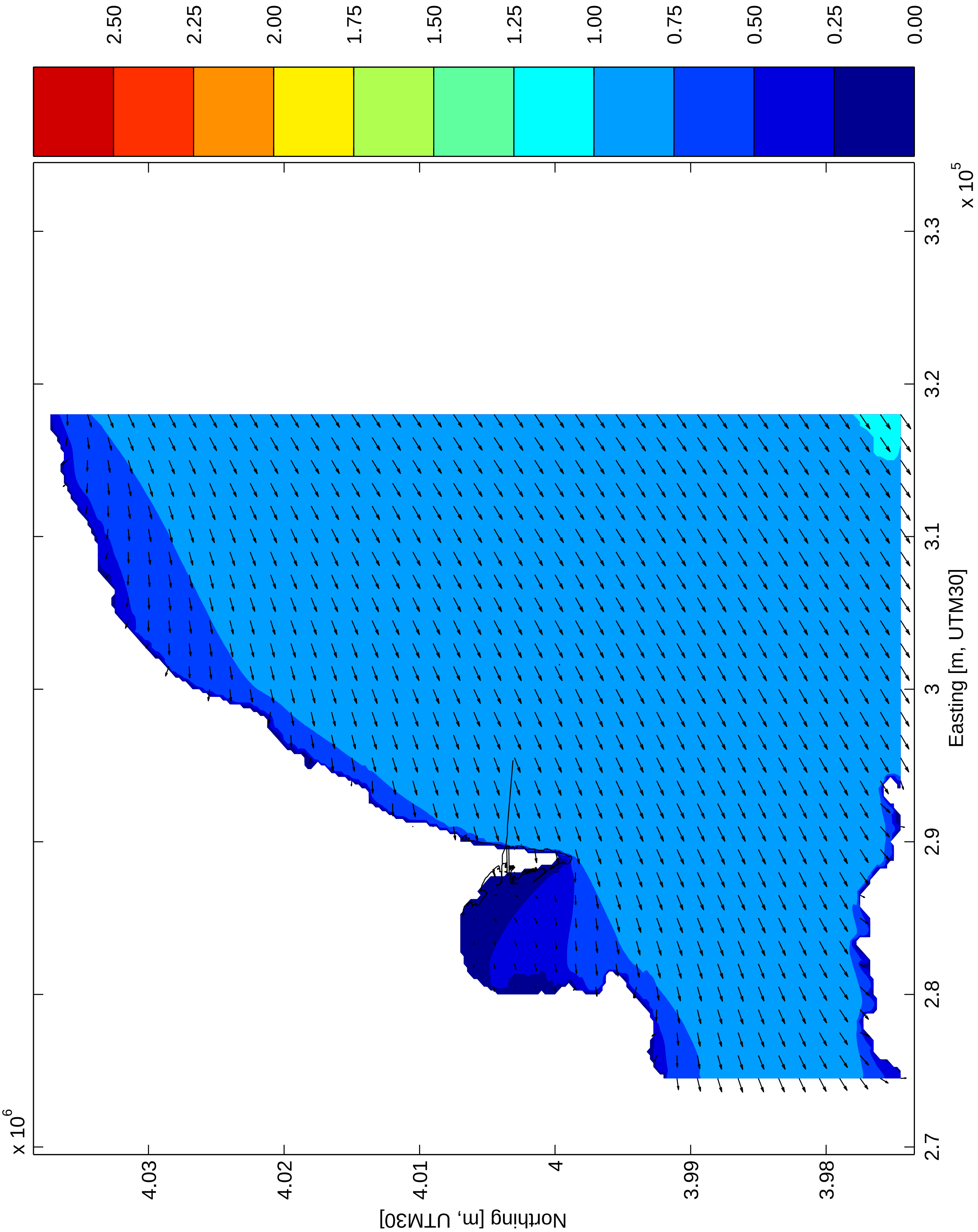


WL | DELFT HYDRAULICS

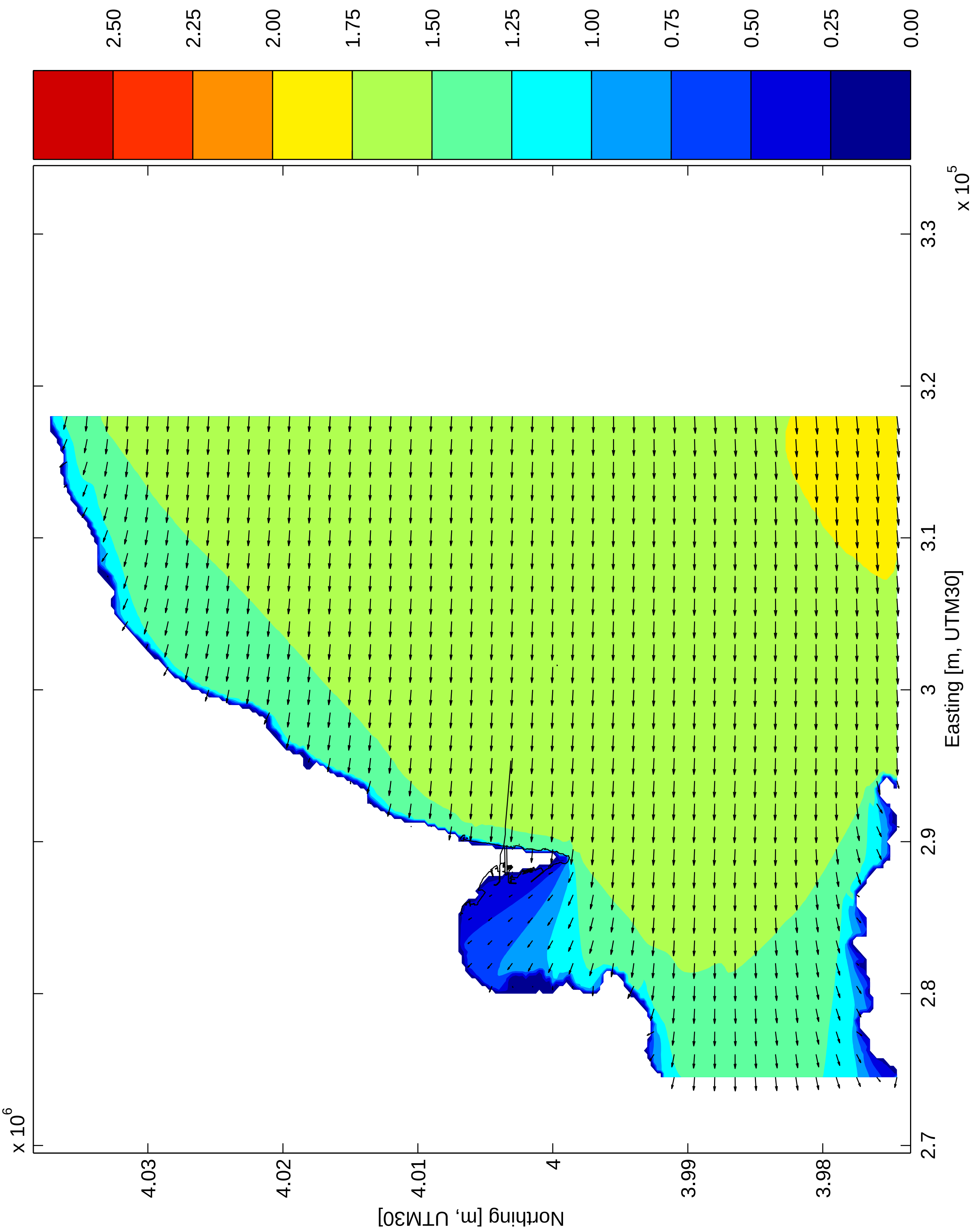
Examples of wave scenarios

H4725

Fig. 4.5



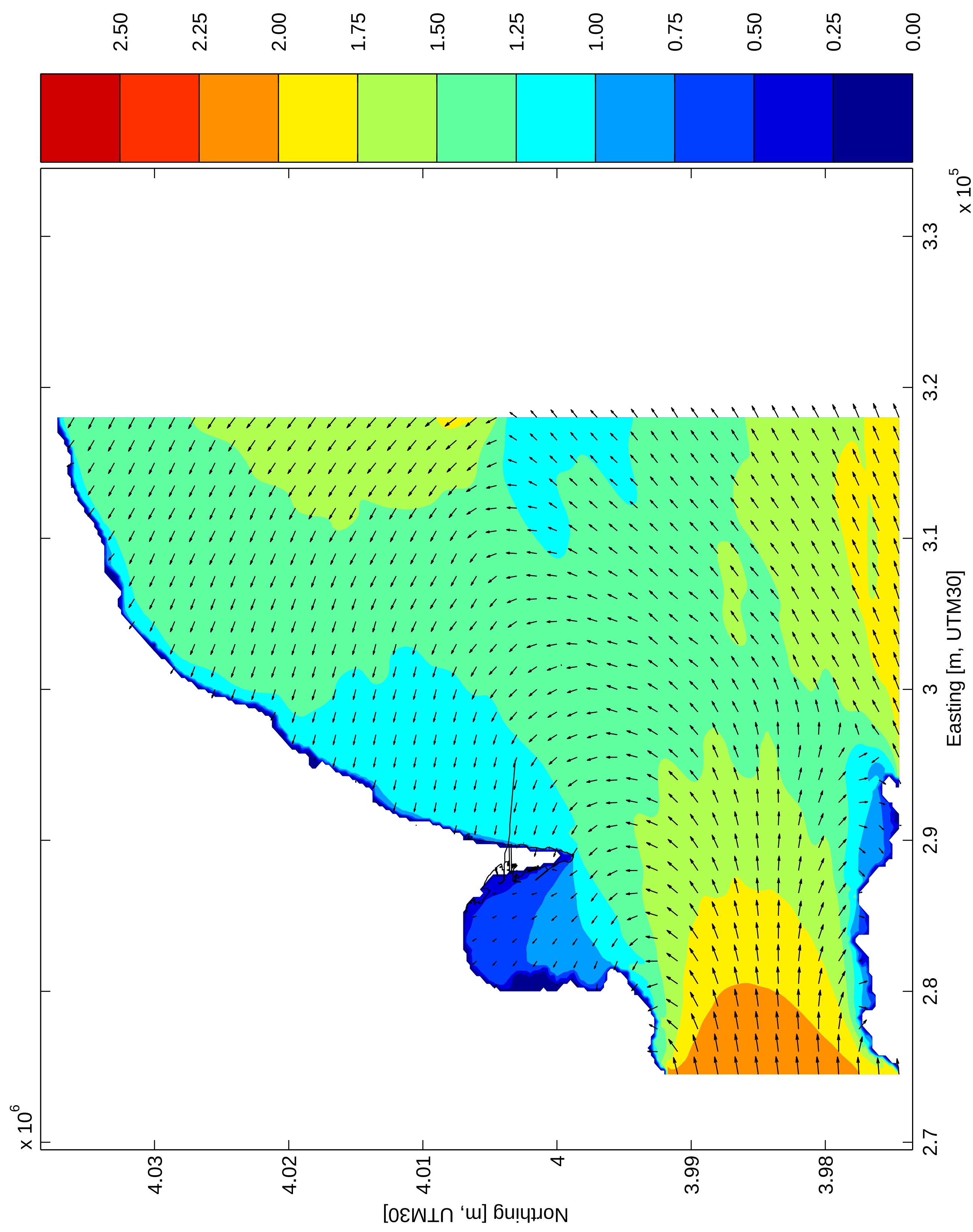
Normal wave condition 17 Significant wave height (m)		
	Delft3D−WAVE	
WL | DELFT HYDRAULICS	H4725	Fig. 4.6



Normal wave condition 34
Significant wave height (m)

Delft3D−WAVE

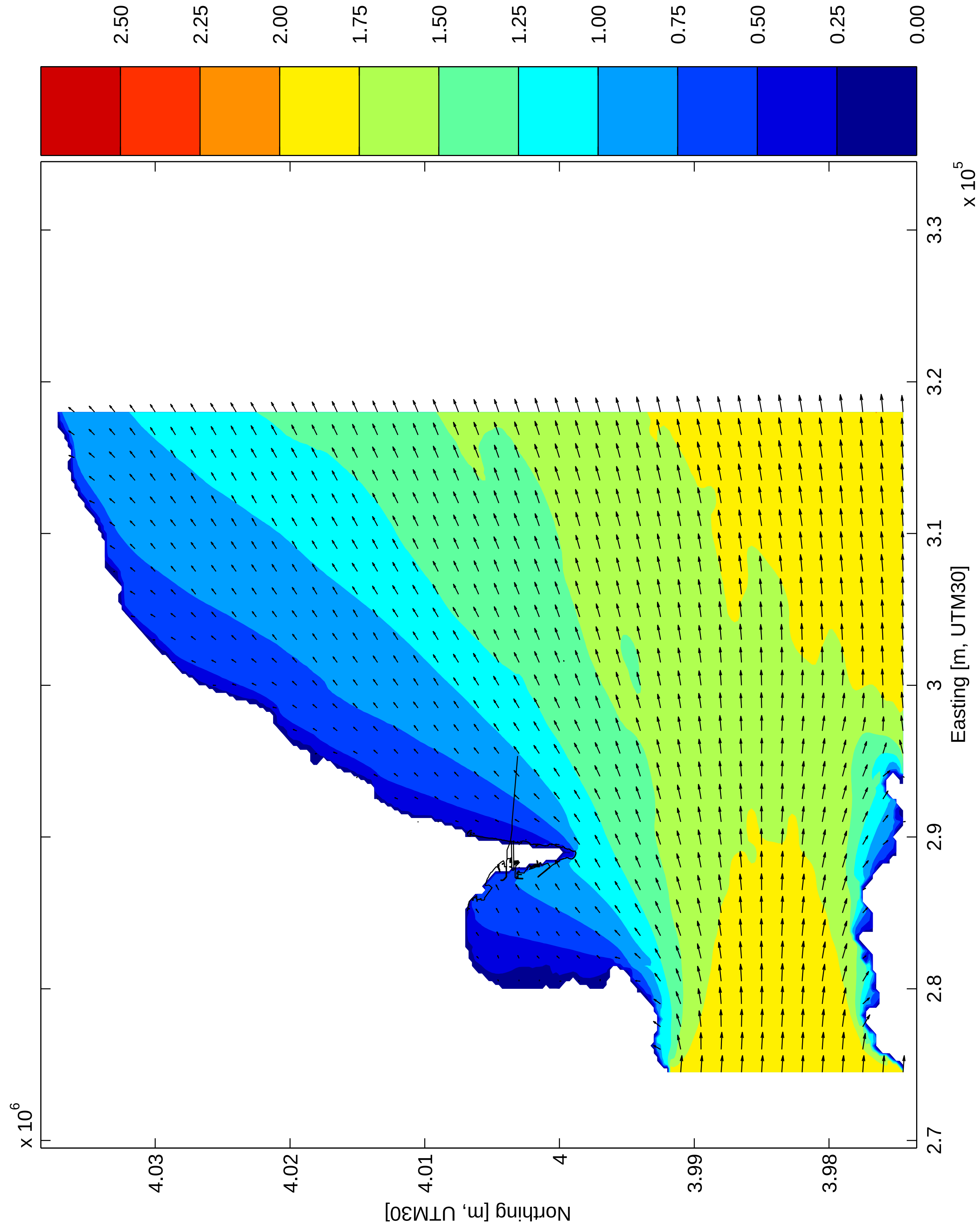
WL | DELFT HYDRAULICS | H4725 | Fig. 4.7



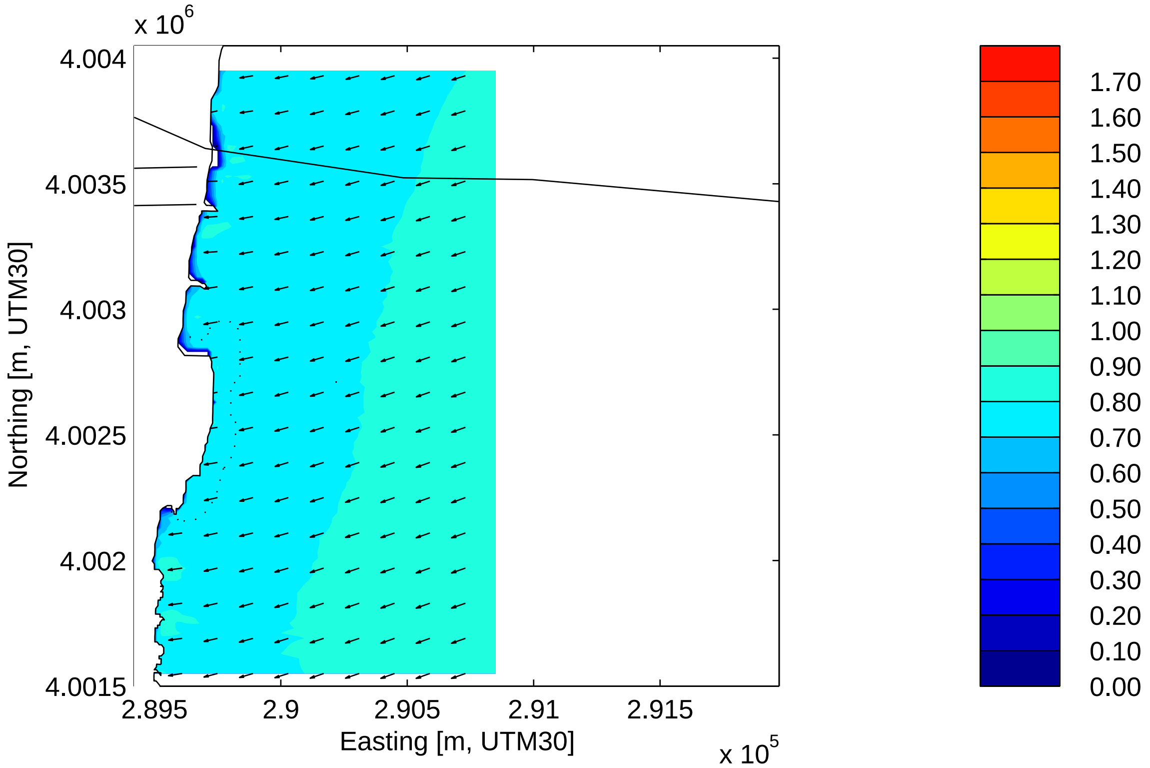
Normal wave condition 36
Significant wave height (m)

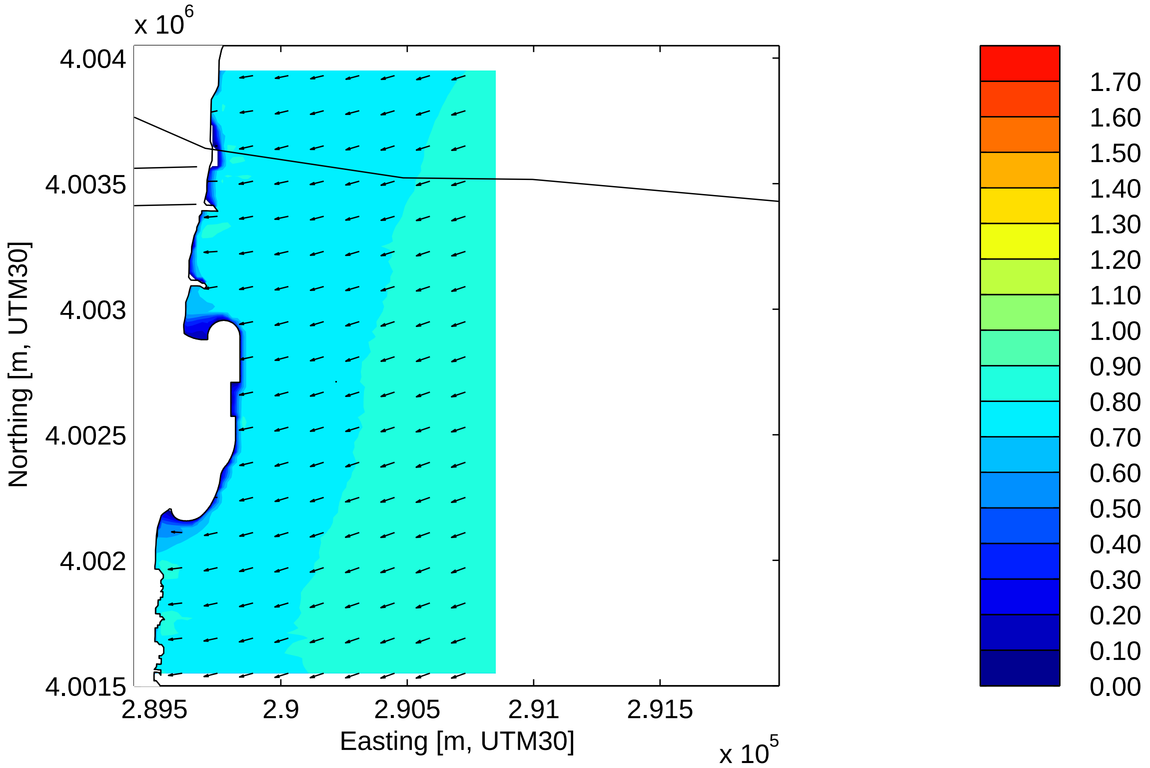
Delft3D−WAVE

WL | DELFT HYDRAULICS | H4725 | Fig. 4.8

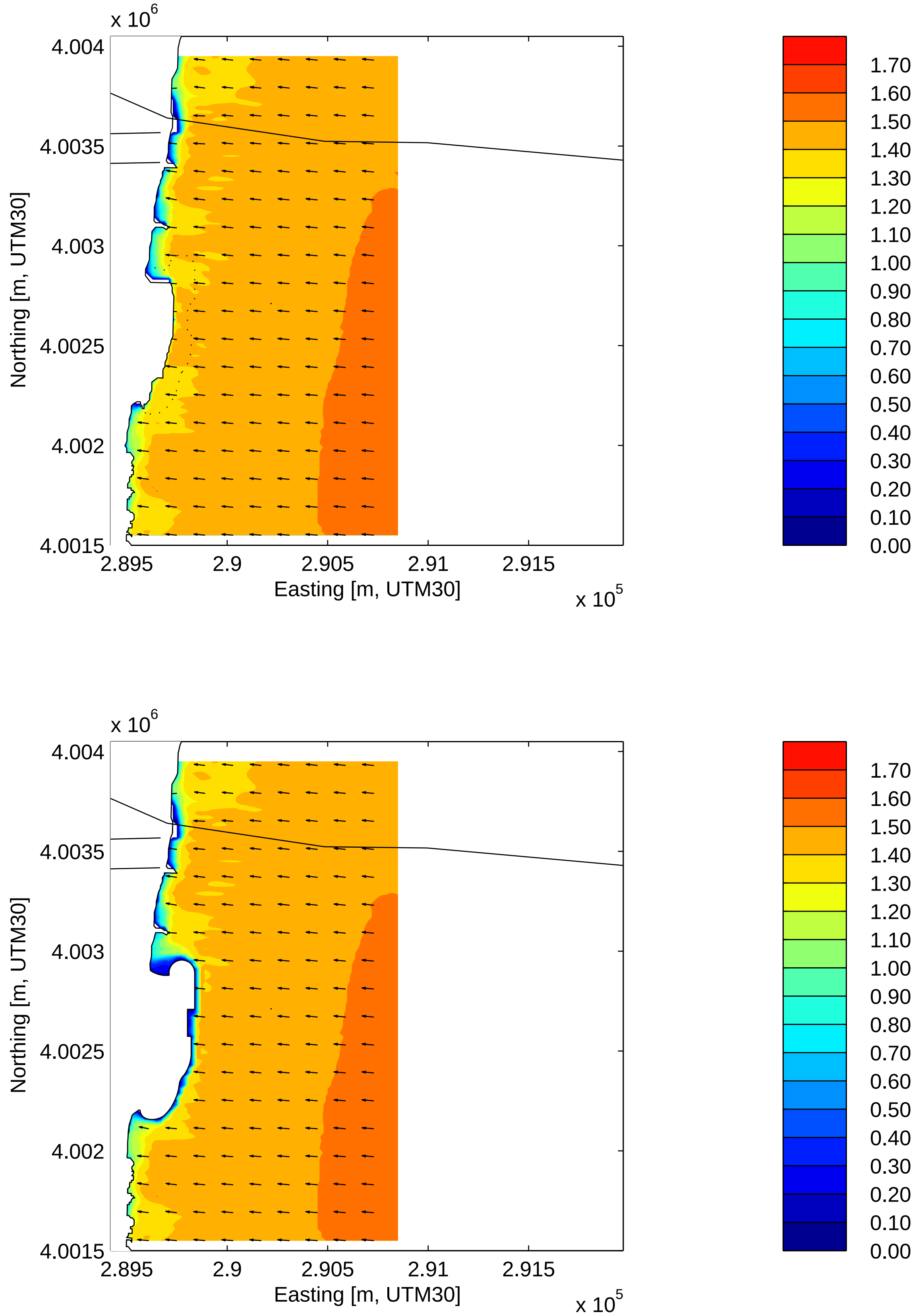


Normal wave condition 44 Significant wave height (m)		
	Delft3D−WAVE	
WL | DELFT HYDRAULICS	H4725	Fig. 4.9





Normal wave condition 17 Significant wave height (m)	Delft3D−WAVE	
WL | DELFT HYDRAULICS	H4725	Fig. 4.10



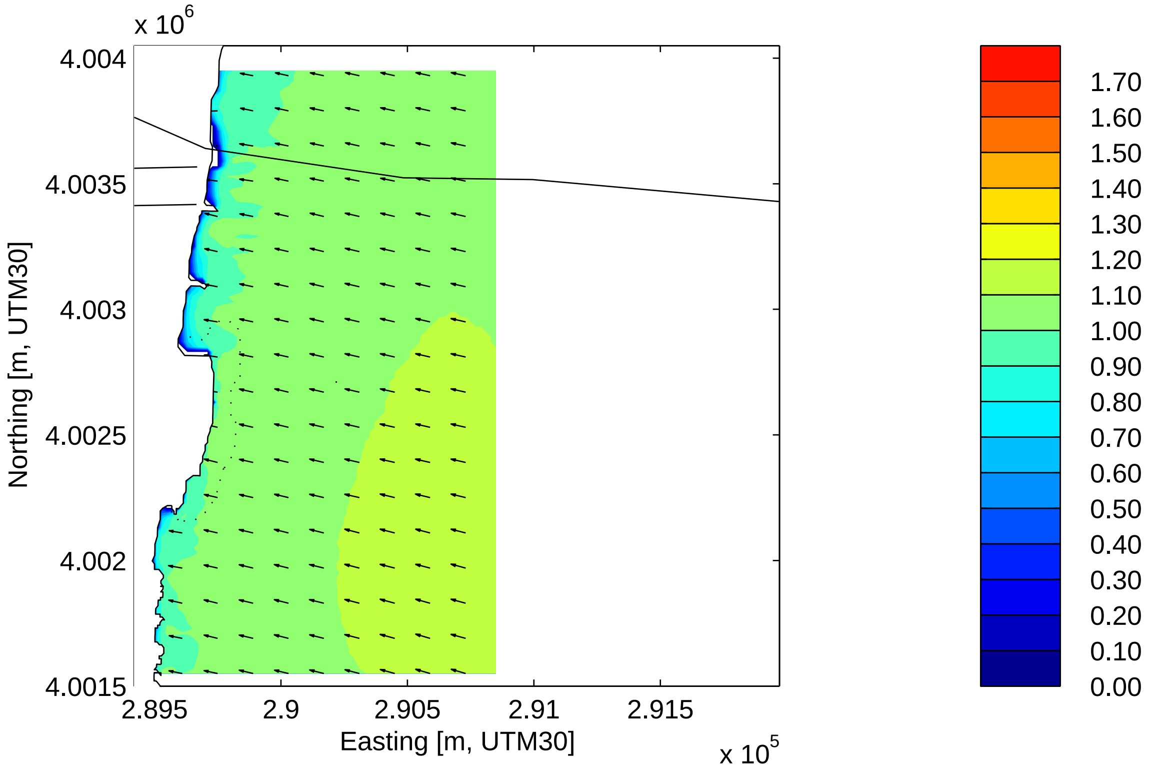
Normal wave condition 34
Significant wave height (m)

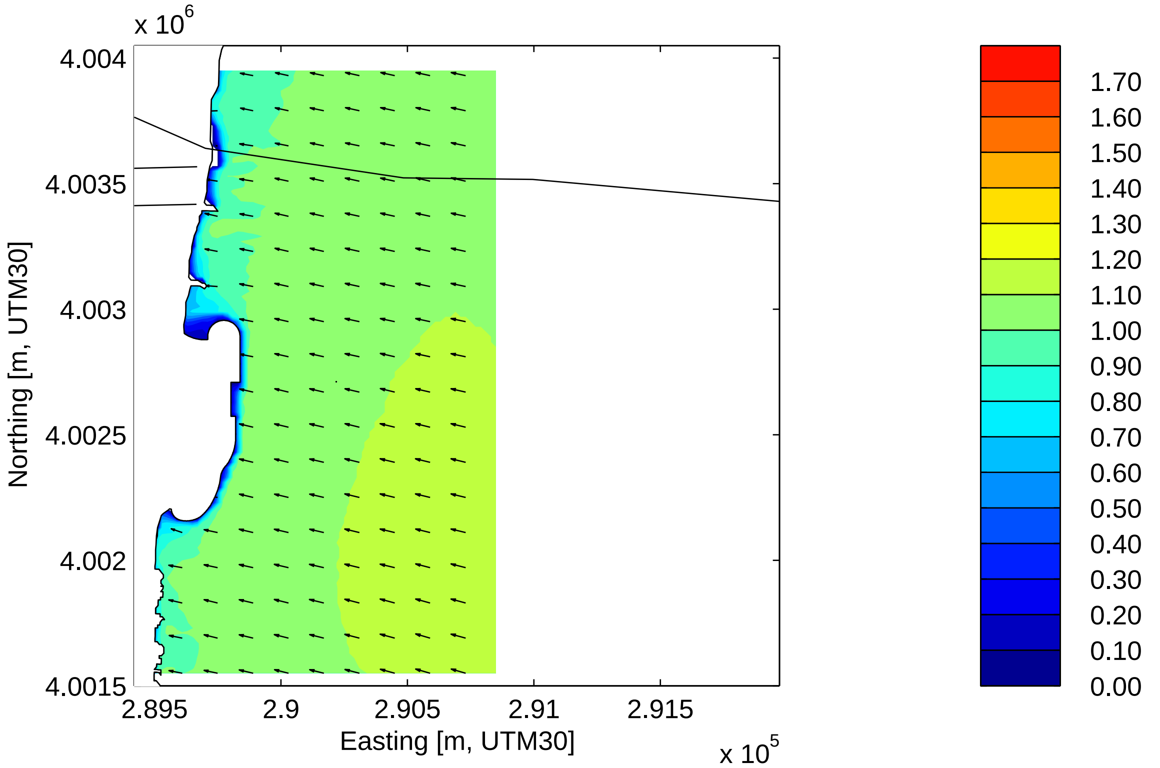
Delft3D−WAVE

WL | DELFT HYDRAULICS

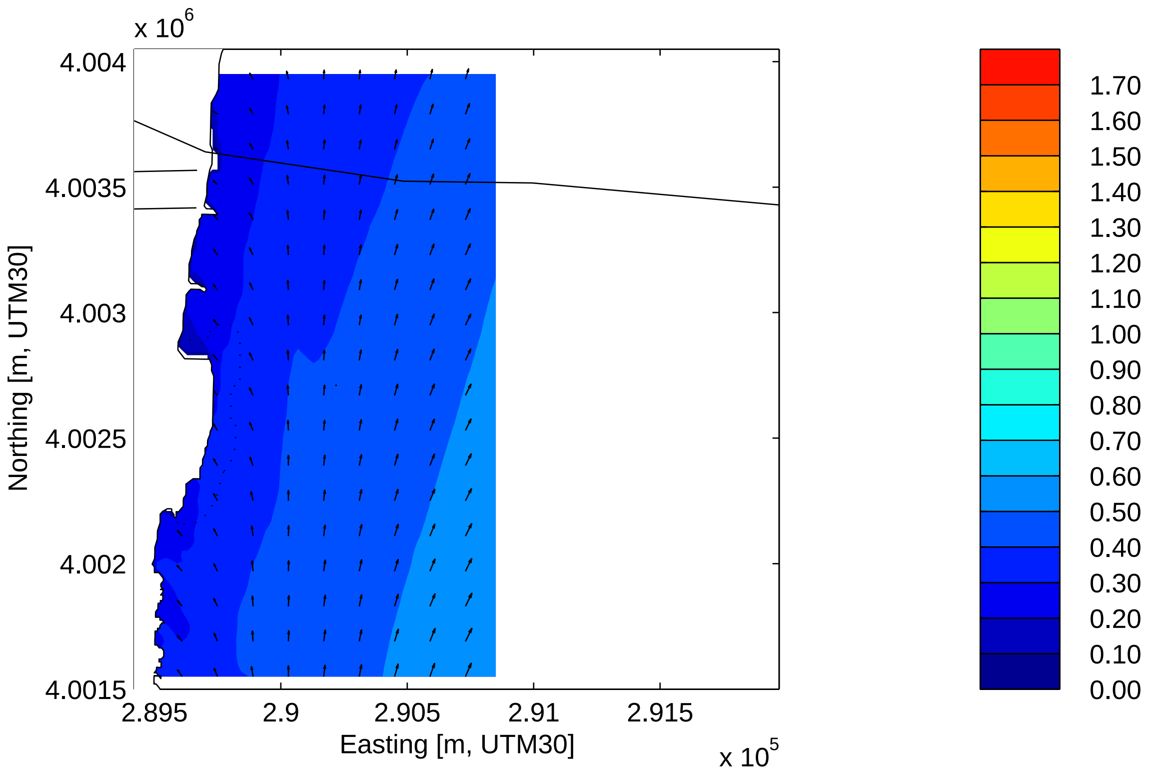
H4725

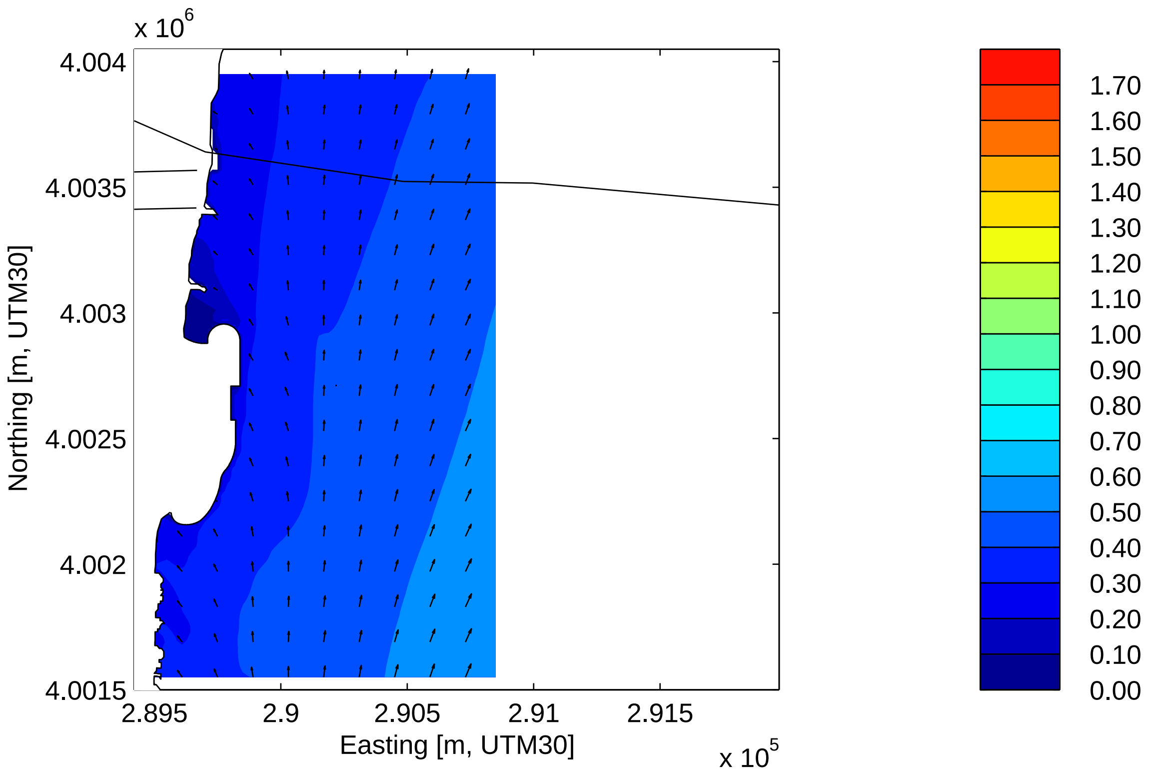
Fig. 4.11





Normal wave condition 36 Significant wave height (m)	Delft3D−WAVE	
WL | DELFT HYDRAULICS	H4725	Fig. 4.12





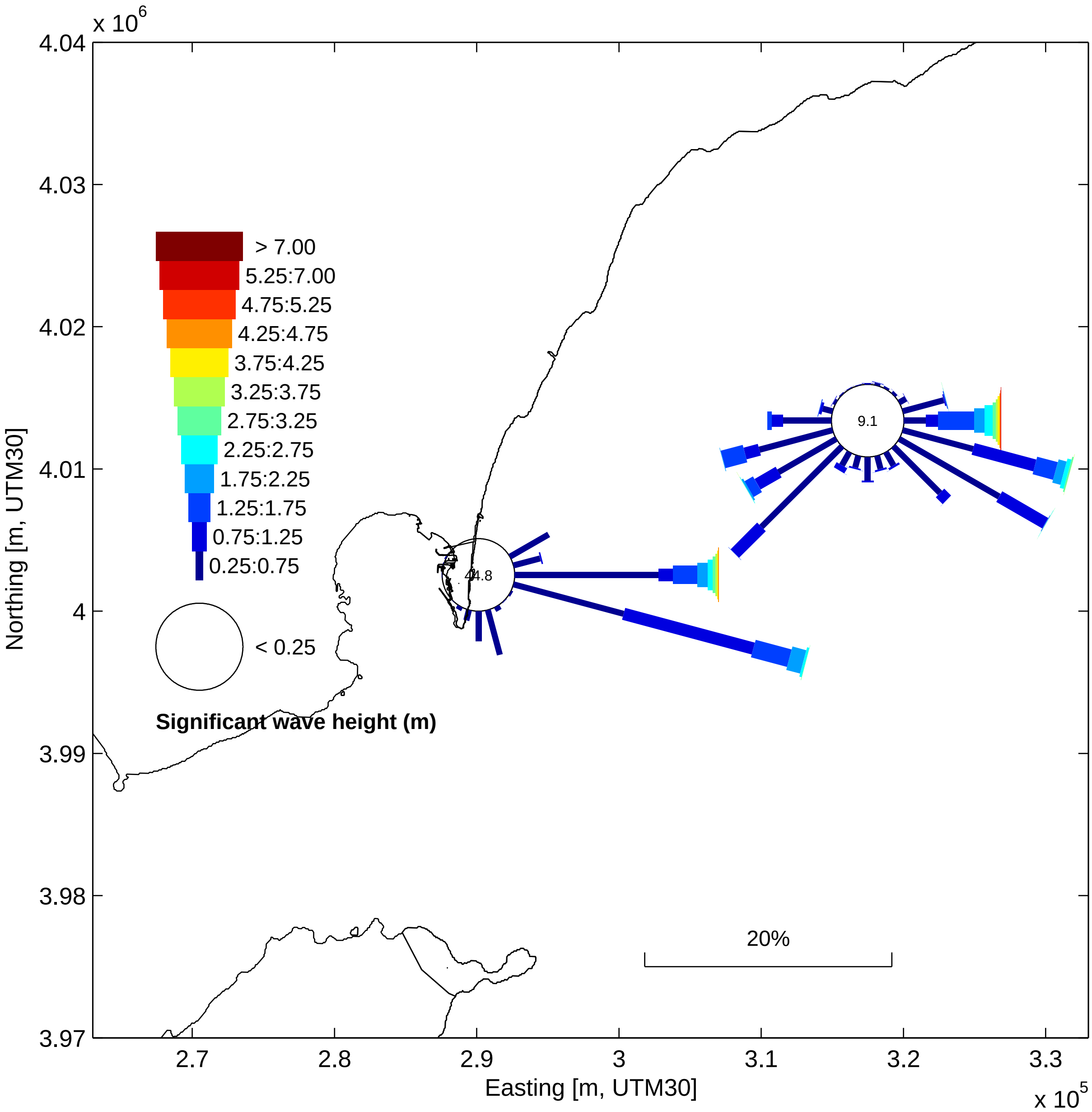
Normal wave condition 44
Significant wave height (m)

Delft3D−WAVE

WL | DELFT HYDRAULICS

H4725

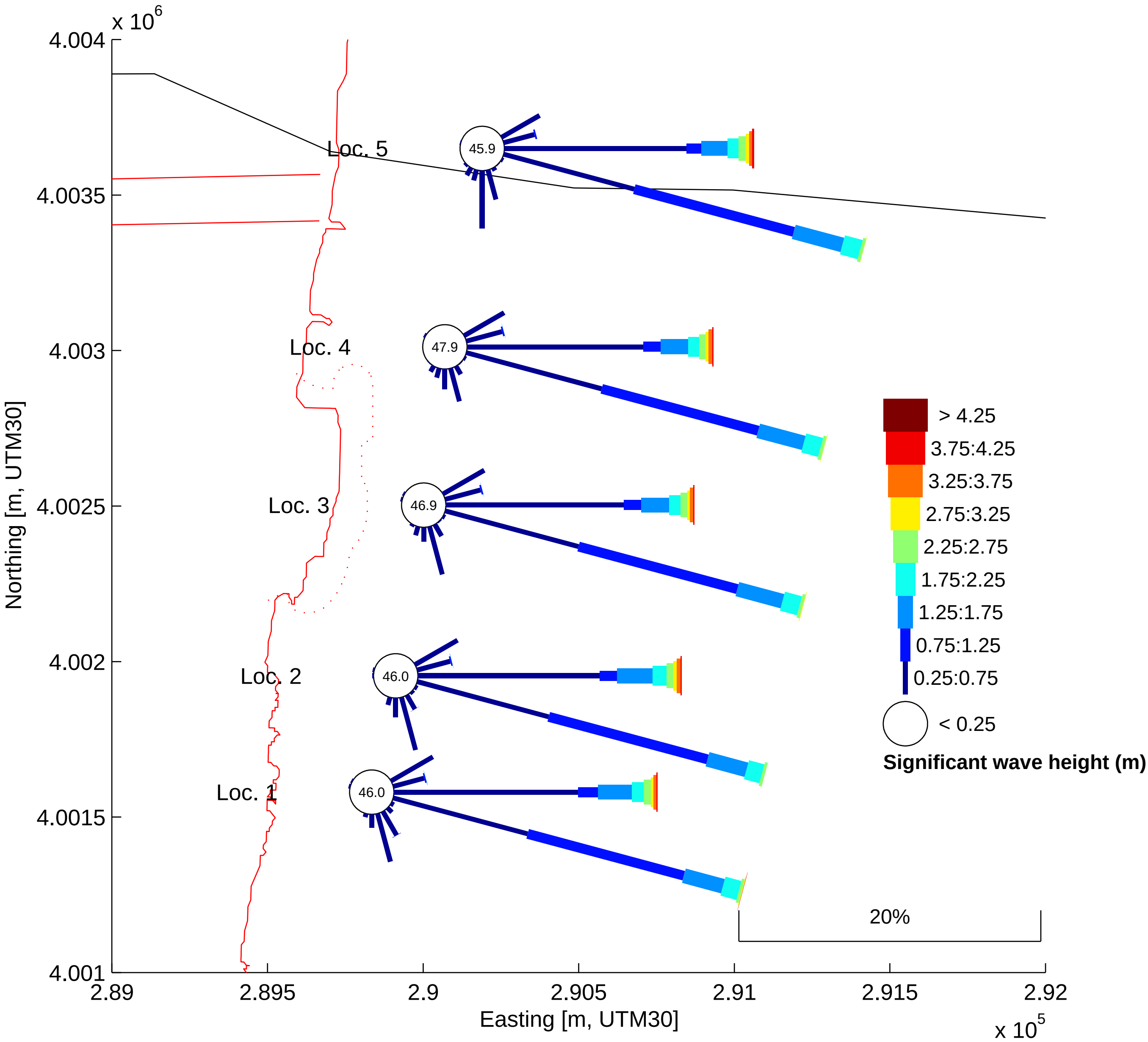
Fig. 4.13



EXPLANATION

Item:	Represents:
Type of bar Direction of bar (to centre of rose) Length of bar Number in centre of rose	Significant wave height (m) Direction Occurence (%) Occurence (%) in lowest class

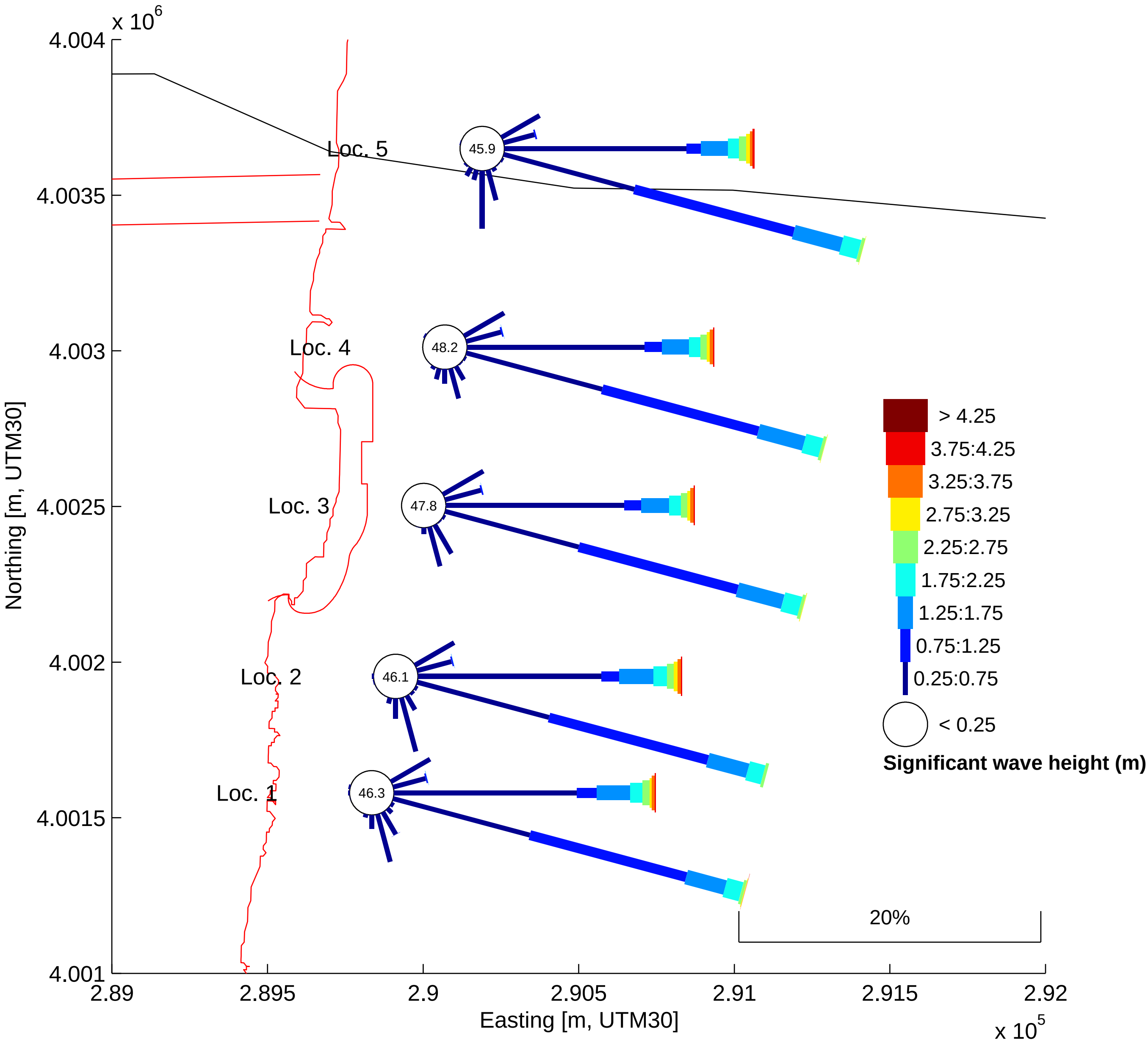
Spatial overview of the normal wave conditions	Without the scheme	
WL | DELFT HYDRAULICS	H4725	Fig. 4.14



EXPLANATION

Item:	Represents:
Type of bar Direction of bar (to centre of rose) Length of bar Number in centre of rose	Significant wave height (m) Direction Occurence (%) Occurence (%) in lowest class

Nearshore wave roses	Without the scheme	
WL | DELFT HYDRAULICS	H4725	Fig. 4.15



EXPLANATION

Item:	Represents:
Type of bar	Significant wave height (m)
Direction of bar (to centre of rose)	Direction
Length of bar	Occurence (%)
Number in centre of rose	Occurence (%) in lowest class

Nearshore wave roses	With the scheme	
WL | DELFT HYDRAULICS	H4725	Fig. 4.16

A Frequency distribution tables

		Mean wave direction (degrees N)																								
Significant		-7.5	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	
wave height (m)	Und.	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	352.5	Total
Undetermined	0.07	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		0.07
< 0.25	.	0.07	0.04	0.07	0.07	0.50	1.92	0.55	0.09	0.06	0.04	0.01	0.01	.	0.02	0.02	0.06	0.38	3.36	1.27	0.25	0.14	0.06	0.03	0.05	9.06
0.25: 0.75	.	0.08	0.21	0.18	0.23	0.64	3.44	1.75	6.08	9.44	5.44	1.24	1.11	1.93	0.98	1.28	9.40	5.50	6.27	3.87	0.83	0.20	0.11	0.08	0.07	60.34
0.75: 1.25	.	0.01	0.05	.	0.01	0.02	0.10	1.11	5.04	4.21	0.68	0.17	0.14	0.12	0.13	0.43	2.87	1.90	1.20	0.88	0.20	0.04	.	0.01	.	19.29
1.25: 1.75	.	.	.	0.01	.	.	0.07	2.84	1.67	0.05	0.01	0.01	0.01	.	0.02	0.01	0.03	0.81	1.77	0.31	0.06	.	.	.	.	7.68
1.75: 2.25	.	.	.	.	.	.	0.02	0.90	0.68	.	.	.	.	.	.	.	.	0.13	0.02	.	.	.	.	.	.	1.75
2.25: 2.75	.	.	.	.	.	.	.	0.61	0.29	0.02	.	.	.	.	.	.	.	0.04	.	.	.	.	.	.	.	0.96
2.75: 3.25	.	.	.	.	.	.	0.01	0.28	0.12	0.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.42
3.25: 3.75	.	.	.	.	.	.	.	0.14	0.02	.	.	.	.	.	.	.	.	0.01	.	.	.	.	.	.	.	0.17
3.75: 4.25	.	.	.	.	.	.	.	0.14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.14
4.25: 4.75	.	.	.	.	.	.	.	0.07	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.07
4.75: 5.25	.	.	.	.	.	.	.	0.05	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.05
5.25: 5.75	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5.75: 6.25	.	.	.	.	.	.	.	0.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.01
6.25: 6.75	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6.75: 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
> 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	0.07	0.16	0.29	0.25	0.31	1.15	5.56	8.43	14.00	13.78	6.17	1.43	1.26	2.04	1.14	1.74	12.35	8.76	12.63	6.34	1.34	0.37	0.17	0.12	0.12	100.00

Table A.1a Significant wave height and mean wave direction frequency distribution of the corrected ECMWF Northeast data (all year, 1999-2005)

		Peak period (s)										
Significant		<3	3	4	5	6	7	8	9	10	11	>13.5	
wave height (m)	Und.		4	5	6	7	8	9	10	11	13.5		Total
Undetermined	0.07	.	.	.	.	.	.	.	.	.	.	.	0.07
< 0.25	.	0.45	0.83	0.72	1.47	1.75	0.75	0.83	0.81	0.53	0.47	0.44	9.06
0.25: 0.75	.	4.1	13.85	9.73	10.4	6.82	2.85	3.17	2.79	1.97	3.18	1.5	60.34
0.75: 1.25	.	0.01	2.75	5.73	5.12	3.29	0.84	0.54	0.34	0.18	0.36	0.14	19.29
1.25: 1.75	.	.	0.03	1.24	3.24	2.08	0.37	0.25	0.12	0.18	0.14	0.03	7.68
1.75: 2.25	.	.	.	.	0.33	1.1	0.17	0.09	0.03	.	0.03	0.01	1.75
2.25: 2.75	.	.	.	.	0.03	0.55	0.29	0.07	0.01	.	0.01	.	0.96
2.75: 3.25	.	.	.	.	.	0.12	0.17	0.1	0.03	.	0.01	.	0.42
3.25: 3.75	.	.	.	.	.	.	0.05	0.11	0.01	.	.	.	0.17
3.75: 4.25	.	.	.	.	.	.	0.02	0.11	0.01	.	.	.	0.14
4.25: 4.75	.	.	.	.	.	.	.	0.04	0.03	.	.	.	0.07
4.75: 5.25	.	.	.	.	.	.	.	.	0.05	.	.	.	0.05
5.25: 5.75	.	.	.	.	.	.	.	.	.	.	.	.	.
5.75: 6.25	.	.	.	.	.	.	.	.	0.01	.	.	.	0.01
6.25: 6.75	.	.	.	.	.	.	.	.	.	.	.	.	.
6.75: 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.
> 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	0.07	4.56	17.46	17.43	20.58	15.7	5.51	5.3	4.24	2.85	4.2	2.11	100

Table A.1b Significant wave height and peak period frequency distribution of the corrected ECMWF Northeast data (all year, 1999-2005)

Significant wave height (m)	Und.	Mean wave direction (degrees N) -7.50 7.50	7.50 22.50	22.50 37.50	37.50 52.50	52.50 67.50	67.50 82.50	82.50 97.50	97.50 112.50	112.50 127.50	127.50 142.50	142.50 157.50	157.50 172.50	172.50 187.50	187.50 202.50	202.50 217.50	217.50 232.50	232.50 247.50	247.50 262.50	262.50 277.50	277.50 292.50	292.50 307.50	307.50 322.50	322.50 337.50	337.50 352.50	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	0.01	.	0.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.01	0.02	0.08	0.07	0.02	0.01	.	0.22
0.25: 0.75	.	0.51	0.68	0.82	0.96	2.15	1.85	0.14	0.03	1.04	1.55	0.51	0.24	0.76	0.01	0.02	0.07	0.07	0.09	6.97	14.22	3.15	1.19	0.73	0.72	38.49
0.75: 1.25	.	0.20	0.25	0.33	0.52	0.98	1.07	0.22	0.37	3.34	2.88	0.87	0.26	0.97	0.06	0.02	0.12	0.10	0.16	9.65	8.96	0.96	0.46	0.32	0.32	33.39
1.25: 1.75	.	0.02	0.04	0.08	0.05	0.22	0.82	2.02	0.39	1.59	0.68	0.09	0.09	0.11	0.07	0.01	0.06	0.18	0.42	7.71	3.82	0.10	0.04	0.06	0.04	18.70
1.75: 2.25	.	.	.	.	0.02	0.04	0.30	1.92	0.03	0.15	0.04	.	.	.	.	.	.	.	0.24	1.22	0.43	0.03	.	0.02	.	4.44
2.25: 2.75	.	0.01	0.01	.	.	.	0.17	1.72	0.01	.	.	0.01	.	.	.	.	0.01	.	0.09	0.63	0.08	.	.	0.01	.	2.74
2.75: 3.25	.	.	.	.	.	.	0.06	0.75	0.01	.	.	.	.	.	0.01	.	.	0.02	0.07	0.12	0.02	.	.	.	.	1.06
3.25: 3.75	.	.	.	.	.	.	0.02	0.28	.	.	.	.	.	.	0.01	.	.	.	0.02	0.05	.	.	.	.	.	0.38
3.75: 4.25	.	.	.	.	.	.	.	0.26	.	.	.	.	.	.	.	.	.	.	0.01	.	.	.	.	.	.	0.27
4.25: 4.75	.	.	.	.	.	.	0.03	0.13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.16
4.75: 5.25	.	.	.	.	.	.	.	0.06	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.06
5.25: 5.75	.	.	.	.	.	.	0.01	0.02	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.03
5.75: 6.25	.	.	.	.	.	.	.	0.05	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.05
6.25: 6.75	.	.	.	.	.	.	.	0.02	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.02
6.75: 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
> 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	.	0.74	0.99	1.24	1.54	3.38	4.32	7.60	0.84	6.12	5.16	1.48	0.60	1.84	0.16	0.05	0.25	0.36	1.10	26.36	27.60	4.30	1.71	1.15	1.09	100.00

Table A.2a Significant wave height and mean wave direction frequency distribution of the corrected ECMWF Southeast data (all year, 1999-2005)

Significant wave height (m)	Und.	Peak period (s) <3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	.	.	0.01	.	0.04	.	.	0.01	0.02	0.06	0.09	0.22
0.25: 0.75	.	0.34	2.89	3.00	4.73	5.23	1.65	2.60	3.92	4.05	7.04	3.02	38.49
0.75: 1.25	.	0.01	2.56	7.10	4.14	3.65	0.96	1.31	1.38	1.77	6.22	4.30	33.39
1.25: 1.75	.	.	0.02	2.90	5.89	2.02	0.62	0.66	0.65	0.43	2.16	3.35	18.70
1.75: 2.25	.	.	.	0.01	1.23	1.51	0.25	0.22	0.13	0.16	0.50	0.44	4.44
2.25: 2.75	.	.	.	.	0.27	1.49	0.35	0.12	0.05	0.10	0.21	0.16	2.74
2.75: 3.25	.	.	.	.	0.01	0.52	0.26	0.06	0.02	0.03	0.10	0.06	1.06
3.25: 3.75	.	.	.	.	.	0.10	0.11	0.10	0.01	0.02	0.04	0.01	0.38
3.75: 4.25	.	.	.	.	.	0.02	0.12	0.12	0.02	.	.	.	0.27
4.25: 4.75	.	.	.	.	.	.	0.03	0.11	0.02	.	.	.	0.16
4.75: 5.25	.	.	.	.	.	.	.	0.05	0.01	.	.	.	0.06
5.25: 5.75	.	.	.	.	.	.	.	0.01	0.02	.	.	.	0.03
5.75: 6.25	.	.	.	.	.	.	.	0.01	0.04	.	.	.	0.05
6.25: 6.75	.	.	.	.	.	.	.	.	0.02	.	.	.	0.02
6.75: 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.
> 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	.	0.35	5.48	13.02	16.27	14.57	4.35	5.35	6.29	6.57	16.32	11.43	100.00

Table A.2b Significant wave height and peak period frequency distribution of the corrected ECMWF Southeast data (all year, 1999-2005)

Significant wave height (m)	Und.	Mean wave direction (degrees N)																								Total
		-7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	.	.	.	.	0.01	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.14	0.09	0.01	.	0.01	0.25
0.25: 0.75	.	0.49	0.71	0.55	0.88	1.27	2.55	0.96	.	.	.	0.01	.	.	.	0.02	0.02	0.10	0.25	4.25	22.50	6.38	1.58	0.74	0.62	43.89
0.75: 1.25	.	0.18	0.17	0.31	0.40	0.80	3.18	4.74	0.02	0.03	0.01	0.02	.	0.01	0.01	0.04	0.04	0.14	0.98	5.52	15.06	1.88	0.36	0.35	0.24	34.48
1.25: 1.75	.	0.02	0.04	0.05	0.09	0.16	1.09	4.17	0.03	0.01	0.02	.	0.01	.	0.03	0.01	0.03	0.14	0.78	2.54	3.83	0.28	0.08	0.04	0.05	13.49
1.75: 2.25	.	.	0.02	0.02	.	0.02	0.27	1.86	0.01	.	.	.	.	.	.	.	.	0.04	0.45	1.41	1.21	0.04	.	0.01	.	5.36
2.25: 2.75	.	.	.	.	0.01	.	0.05	0.61	.	.	.	.	.	.	.	.	0.01	0.01	0.22	0.52	0.31	.	0.01	.	.	1.75
2.75: 3.25	.	0.02	0.02	.	.	.	.	0.16	.	.	.	.	.	.	.	.	.	0.02	0.07	0.20	0.04	.	.	.	.	0.52
3.25: 3.75	.	.	.	.	.	.	.	0.10	.	.	.	.	.	.	.	.	.	.	0.05	0.04	0.02	.	.	.	.	0.21
3.75: 4.25	.	.	.	.	.	.	.	0.03	.	.	.	.	.	.	.	.	.	.	.	0.02	.	.	.	.	.	0.05
4.25: 4.75	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4.75: 5.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5.25: 5.75	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5.75: 6.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6.25: 6.75	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
6.75: 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
> 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	.	0.70	0.96	0.93	1.38	2.26	7.14	12.62	0.06	0.04	0.03	0.03	0.01	0.01	0.04	0.07	0.10	0.44	2.81	14.50	43.11	8.67	2.04	1.14	0.92	100.00

Table A.3a Significant wave height and mean wave direction frequency distribution of the corrected ECMWF Western data (all year, 1999-2005)

Significant wave height (m)	Und.	Peak period (s)											Total
		<3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	.	.	.	.	.	.	0.01	0.01	0.04	0.11	0.09	0.25
0.25: 0.75	.	0.10	1.61	1.46	4.20	5.43	2.11	4.01	5.76	5.99	9.71	3.51	43.89
0.75: 1.25	.	.	0.94	3.80	3.22	4.01	0.97	1.32	1.96	2.79	9.48	6.00	34.48
1.25: 1.75	.	.	.	0.44	2.85	2.17	0.61	0.68	0.63	0.41	2.21	3.49	13.49
1.75: 2.25	.	.	.	.	0.27	1.54	0.33	0.47	0.29	0.17	0.88	1.41	5.36
2.25: 2.75	.	.	.	.	.	0.28	0.24	0.17	0.22	0.14	0.35	0.35	1.75
2.75: 3.25	.	.	.	.	.	0.01	0.08	0.08	0.03	0.06	0.12	0.15	0.52
3.25: 3.75	.	.	.	.	.	.	.	0.06	0.04	0.03	0.05	0.03	0.21
3.75: 4.25	.	.	.	.	.	.	.	.	0.03	.	.	0.02	0.05
4.25: 4.75	.	.	.	.	.	.	.	.	.	.	.	.	.
4.75: 5.25	.	.	.	.	.	.	.	.	.	.	.	.	.
5.25: 5.75	.	.	.	.	.	.	.	.	.	.	.	.	.
5.75: 6.25	.	.	.	.	.	.	.	.	.	.	.	.	.
6.25: 6.75	.	.	.	.	.	.	.	.	.	.	.	.	.
6.75: 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.
> 7.25	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	.	0.10	2.55	5.70	10.55	13.43	4.34	6.80	8.96	9.62	22.91	15.05	100.00

Table A.3b Significant wave height and peak period frequency distribution of the corrected ECMWF Western data (all year, 1999-2005)

		Wind direction (degrees N)																								
WInd speed (m/s)	Und.	-7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	7.81	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7.81
< 0.7	.	0.02	0.02	0.04	.	0.01	0.01	0.03	0.04	0.02	0.05	0.03	0.03	0.03	0.03	0.05	0.04	.	0.01	0.06	0.02	0.02	0.04	0.01	0.02	0.62
0.7: 2.35	.	0.42	0.43	0.40	0.50	0.63	0.84	0.60	0.70	0.75	0.55	0.55	0.54	0.31	0.25	0.27	0.32	0.43	0.58	0.64	0.54	0.41	0.45	0.38	0.33	11.82
2.35: 6.65	.	0.38	0.46	0.55	0.91	1.93	5.65	7.49	3.70	1.48	0.66	0.55	0.36	0.30	0.35	0.45	0.83	1.40	3.20	6.02	5.62	2.98	1.71	0.81	0.47	48.26
6.65: 11.35	.	0.09	0.06	0.08	0.14	0.39	2.44	6.28	1.33	0.22	0.08	0.06	0.03	0.02	0.05	0.17	0.27	0.94	2.56	5.89	4.74	1.64	0.32	0.08	0.06	27.93
11.35: 16.45	.	.	.	0.01	.	0.03	0.25	1.00	0.41	0.04	.	.	.	.	.	0.02	0.09	0.15	0.22	0.63	0.47	0.14	0.01	.	0.01	3.46
16.45: 21.85	.	.	.	.	.	.	.	0.07	0.01	.	.	.	.	.	.	.	.	.	0.01	.	0.01	.	.	.	.	0.10
21.85: 28.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
> 28.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	7.81	0.91	0.97	1.08	1.54	2.98	9.20	15.46	6.19	2.51	1.34	1.18	0.96	0.66	0.68	0.96	1.55	2.91	6.57	13.23	11.40	5.19	2.53	1.28	0.89	100.00

Table A.4 10-m wind speed and direction frequency distribution of the averaged HIRLAM data (all year, 1999-2005)

		Mean wave direction (degrees N)																							
Significant wave height (m)	Und.	-7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	.	0.04	0.06	0.06	1.69	0.89	4.00	12.65	4.72	5.54	6.68	7.44	0.53	0.04	0.07	0.02	0.04	0.06	0.05	0.10	0.03	0.04	0.08	0.02	44.83
0.25: 0.75	.	.	.	.	.	3.62	2.24	11.64	9.28	0.17	0.06	0.39	3.74	2.41	0.87	0.30	0.03	.	.	0.01	0.08	0.12	0.01	.	.	34.96
0.75: 1.25	.	.	.	.	.	.	0.12	1.16	10.83	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12.11
1.25: 1.75	.	.	.	.	.	.	.	1.99	3.02	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5.01
1.75: 2.25	.	.	.	.	.	.	.	0.80	1.15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.96
2.25: 2.75	.	.	.	.	.	.	.	0.43	0.18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.61
2.75: 3.25	.	.	.	.	.	.	.	0.20	0.03	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.23
3.25: 3.75	.	.	.	.	.	.	.	0.17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.17
3.75: 4.25	.	.	.	.	.	.	.	0.09	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.09
4.25: 4.75	.	.	.	.	.	.	.	0.05	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.05
4.75: 5.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5.25: 5.75	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5.75: 6.25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	.	.	0.04	0.06	0.06	5.31	3.25	20.53	37.14	4.88	5.60	7.07	11.17	2.94	0.91	0.37	0.05	0.04	0.06	0.06	0.18	0.15	0.05	0.08	0.02	100.00

Table A.5a Significant wave height and mean wave direction frequency distribution at the 10 m OD depth line (x= 290119 m, y= 4002550 m, all year, without the scheme).

		Peak period (s)											
Significant wave height (m)	Und.	<3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.08	3.07	5.60	6.52	5.84	3.95	2.84	2.07	1.55	4.78	7.53	44.83
0.25: 0.75	.	5.09	4.59	6.21	5.09	4.77	4.30	1.82	0.91	0.55	0.87	0.76	34.96
0.75: 1.25	.	0.13	0.18	0.87	2.77	3.11	3.52	0.80	0.42	0.11	0.12	0.09	12.11
1.25: 1.75	.	.	0.02	0.23	1.37	2.55	0.73	0.07	0.02	0.01	.	.	5.01
1.75: 2.25	.	.	.	0.02	0.21	0.81	0.81	0.08	.	0.01	0.01	0.01	1.96
2.25: 2.75	.	.	.	.	.	0.17	0.35	0.08	.	.	0.01	.	0.61
2.75: 3.25	.	.	.	.	.	0.01	0.12	0.09	0.01	.	.	.	0.23
3.25: 3.75	.	.	.	.	.	.	0.05	0.11	0.01	.	.	.	0.17
3.75: 4.25	.	.	.	.	.	.	.	0.06	0.03	.	.	.	0.09
4.25: 4.75	.	.	.	.	.	.	.	0.01	0.04	.	.	.	0.05
4.75: 5.25	.	.	.	.	.	.	.	.	.	.	.	.	.
5.25: 5.75	.	.	.	.	.	.	.	.	.	.	.	.	.
5.75: 6.25	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	.	6.29	7.86	12.93	15.95	17.27	13.83	5.95	3.51	2.22	5.79	8.39	100.00

Table A.5b Significant wave height and peak period frequency distribution at the nearshore 10 m OD depth line (x= 290119 m, y= 4002550 m, all year, without the scheme).

		Mean wave direction (degrees N)																							
Significant		-7.5	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	
wave height (m)	Und.	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.01	0.01	1.53	0.74	2.57	14.59	4.49	6.27	11.88	3.34	0.10	0.06	0.06	0.05	0.06	0.10	0.07	0.05	0.02	-	0.01	0.01	46.02
0.25: 0.75	.	-	-	-	-	3.21	2.11	12.19	9.22	0.22	0.42	1.82	3.31	0.89	0.24	-	-	-	0.01	0.03	0.11	0.09	-	-	-	33.86
0.75: 1.25	.	-	-	-	-	-	0.10	1.32	10.70	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.14
1.25: 1.75	.	-	-	-	-	-	0.02	2.24	2.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.94
1.75: 2.25	.	-	-	-	-	-	-	0.79	1.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.89
2.25: 2.75	.	-	-	-	-	-	-	0.47	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.66
2.75: 3.25	.	-	-	-	-	-	-	0.16	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21
3.25: 3.75	.	-	-	-	-	-	-	0.21	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.06	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.01	0.01	4.74	2.97	20.01	38.54	4.71	6.69	13.72	6.64	0.99	0.30	0.06	0.05	0.06	0.11	0.10	0.16	0.11	-	0.01	0.01	100.00

Table A.6a Significant wave height and mean wave direction frequency distribution at the nearshore location 1 (x= 289835 m, y= 4001580 m, all year, without the scheme).

		Peak period (s)											
Significant		<3	3	4	5	6	7	8	9	10	11	>13.5	
wave height (m)	Und.		4	5	6	7	8	9	10	11	13.5		Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.11	2.85	5.40	6.78	6.71	4.22	2.93	2.05	1.58	4.89	7.51	46.02
0.25: 0.75	.	4.94	4.27	5.60	4.73	5.15	4.47	1.65	0.91	0.51	0.83	0.81	33.86
0.75: 1.25	.	0.12	0.17	0.84	2.65	3.17	3.49	0.94	0.45	0.13	0.10	0.09	12.14
1.25: 1.75	.	-	0.03	0.23	1.37	2.47	0.71	0.08	0.04	-	0.02	-	4.94
1.75: 2.25	.	-	-	0.02	0.18	0.79	0.79	0.08	-	-	0.02	0.01	1.89
2.25: 2.75	.	-	-	-	-	0.17	0.39	0.09	0.01	-	-	-	0.66
2.75: 3.25	.	-	-	-	-	0.01	0.09	0.09	0.01	-	0.01	-	0.21
3.25: 3.75	.	-	-	-	-	-	0.05	0.15	0.02	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.02	0.05	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.16	7.31	12.08	15.70	18.46	14.22	6.02	3.54	2.21	5.87	8.42	100.00

Table A.6b Significant wave height and peak period frequency distribution at the nearshore location 1 (x= 289835 m, y= 4001580 m, all year, without the scheme).

		Mean wave direction (degrees N)																								
Significant		-7.5	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	
wave height (m)	Und.	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.01	0.01	1.47	0.74	2.87	14.34	4.44	6.43	11.15	3.81	0.16	0.06	0.07	0.06	0.09	0.10	0.06	0.04	0.01	-	0.02	0.01	45.96
0.25: 0.75	.	-	-	-	-	3.26	2.26	12.04	9.02	0.19	0.18	1.08	3.62	1.27	0.53	0.04	-	-	0.02	0.08	0.11	-	-	-	-	33.68
0.75: 1.25	.	-	-	-	-	-	0.10	1.15	10.88	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	12.14
1.25: 1.75	.	-	-	-	-	-	0.02	2.35	2.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.04
1.75: 2.25	.	-	-	-	-	-	-	0.93	1.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.99
2.25: 2.75	.	-	-	-	-	-	-	0.43	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	-	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25
3.25: 3.75	.	-	-	-	-	-	-	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.01	0.01	4.73	3.12	20.33	38.17	4.63	6.60	12.24	7.43	1.43	0.59	0.11	0.06	0.09	0.12	0.14	0.15	0.01	-	0.02	0.01	100.00

Table A.7a Significant wave height and mean wave direction frequency distribution at the nearshore location 2 (x= 289912 m, y= 4001954 m, all year, without the scheme).

		Peak period (s)											
Significant		<3	3	4	5	6	7	8	9	10	11	>13.5	
wave height (m)	Und.		4	5	6	7	8	9	10	11	13.5		Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.12	3.02	5.70	6.93	6.16	3.99	2.90	2.06	1.57	4.91	7.60	45.96
0.25: 0.75	.	5.06	4.30	5.56	4.74	4.92	4.30	1.84	0.91	0.51	0.81	0.72	33.68
0.75: 1.25	.	0.13	0.17	0.84	2.61	3.08	3.52	0.96	0.48	0.14	0.12	0.10	12.14
1.25: 1.75	.	-	0.04	0.22	1.40	2.55	0.69	0.08	0.04	-	0.02	-	5.04
1.75: 2.25	.	-	-	0.04	0.23	0.82	0.79	0.08	-	-	0.02	0.01	1.99
2.25: 2.75	.	-	-	-	-	0.19	0.38	0.06	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	0.01	0.12	0.11	0.01	-	0.01	-	0.25
3.25: 3.75	.	-	-	-	-	-	0.06	0.15	0.03	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.03	0.05	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.30	7.53	12.36	15.90	17.74	13.86	6.19	3.58	2.21	5.89	8.43	100.00

Table A.7b Significant wave height and peak period frequency distribution at the nearshore location 2 (x= 289912 m, y= 4001954 m, all year, without the scheme).

Significant wave height (m)	Und.	Mean wave direction (degrees N) -7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.04	0.03	1.50	0.88	3.89	13.84	4.60	6.13	10.57	4.97	0.07	0.04	0.07	0.03	0.04	0.06	0.07	0.10	-	-	-	-	46.94
0.25: 0.75	.	-	-	-	-	3.16	2.43	11.78	9.15	0.16	0.08	0.90	3.29	0.95	0.61	0.16	-	-	-	0.01	0.11	0.11	-	-	-	32.87
0.75: 1.25	.	-	-	-	-	-	0.11	1.14	10.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.13
1.25: 1.75	.	-	-	-	-	-	0.01	1.86	3.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.96
1.75: 2.25	.	-	-	-	-	-	-	0.76	1.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.94
2.25: 2.75	.	-	-	-	-	-	-	0.44	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.64
2.75: 3.25	.	-	-	-	-	-	-	0.19	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.25: 3.75	.	-	-	-	-	-	-	0.22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.04	0.03	4.66	3.42	20.36	38.37	4.75	6.21	11.47	8.26	1.02	0.65	0.23	0.03	0.04	0.06	0.08	0.21	0.11	-	-	-	100.00

Table A.8a Significant wave height and mean wave direction frequency distribution at the nearshore location 3 (x= 290002 m, y= 4002503 m, all year, without the scheme).

Significant wave height (m)	Und.	Peak period (s) <3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.13	3.09	5.89	7.11	6.41	4.14	2.91	2.07	1.60	4.91	7.68	46.94
0.25: 0.75	.	5.17	4.45	5.94	4.42	4.23	4.11	1.77	0.89	0.52	0.74	0.64	32.87
0.75: 1.25	.	0.12	0.18	0.86	2.76	3.15	3.50	0.85	0.42	0.12	0.10	0.08	12.13
1.25: 1.75	.	-	0.03	0.23	1.36	2.50	0.71	0.07	0.03	-	0.02	-	4.96
1.75: 2.25	.	-	-	0.02	0.21	0.80	0.80	0.08	-	0.01	0.01	0.01	1.94
2.25: 2.75	.	-	-	-	-	0.17	0.38	0.08	-	-	0.01	-	0.64
2.75: 3.25	.	-	-	-	-	0.01	0.11	0.10	0.01	-	-	-	0.23
3.25: 3.75	.	-	-	-	-	-	0.05	0.14	0.03	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.02	0.05	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.41	7.75	12.94	15.86	17.27	13.80	6.02	3.50	2.25	5.79	8.40	100.00

Table A.8b Significant wave height and peak period frequency distribution at the nearshore location 3 (x= 290002 m, y= 4002503 m, all year, without the scheme).

		Mean wave direction (degrees N)																								
Significant wave height (m)	Und.	-7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.01	0.04	1.50	1.30	4.22	13.02	4.44	5.16	8.80	8.19	0.56	0.08	0.06	0.06	0.08	0.05	0.11	0.15	0.03	-	0.01	-	47.86
0.25: 0.75	.	-	-	-	-	3.06	2.45	11.68	9.28	0.14	0.06	0.64	2.27	1.34	0.65	0.43	0.05	-	-	-	0.02	0.11	-	-	-	32.17
0.75: 1.25	.	-	-	-	-	-	0.11	1.14	10.72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.98
1.25: 1.75	.	-	-	-	-	-	0.01	1.80	3.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.93
1.75: 2.25	.	-	-	-	-	-	-	0.75	1.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.91
2.25: 2.75	.	-	-	-	-	-	-	0.42	0.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	-	-	0.20	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.25: 3.75	.	-	-	-	-	-	-	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.01	0.04	4.56	3.86	20.52	37.54	4.58	5.21	9.43	10.46	1.90	0.72	0.49	0.11	0.08	0.05	0.11	0.17	0.14	-	0.01	-	100.00

Table A.9a Significant wave height and mean wave direction frequency distribution at the nearshore location 4 (x= 290070 m, y= 4003012 m, all year, without the scheme).

		Peak period (s)											
Significant wave height (m)	Und.	<3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.21	3.31	6.06	7.28	6.66	4.07	2.88	2.12	1.60	4.93	7.74	47.86
0.25: 0.75	.	5.21	4.70	5.66	4.09	4.02	4.11	1.71	0.90	0.47	0.73	0.57	32.17
0.75: 1.25	.	0.12	0.17	0.85	2.75	3.17	3.45	0.79	0.40	0.11	0.09	0.08	11.98
1.25: 1.75	.	-	0.03	0.23	1.35	2.48	0.72	0.07	0.03	0.01	0.01	-	4.93
1.75: 2.25	.	-	-	0.02	0.20	0.79	0.79	0.08	-	0.01	0.01	0.01	1.91
2.25: 2.75	.	-	-	-	-	0.17	0.38	0.08	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	0.01	0.10	0.10	0.01	-	0.01	-	0.23
3.25: 3.75	.	-	-	-	-	-	0.06	0.14	0.03	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.03	0.05	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.55	8.20	12.82	15.66	17.30	13.69	5.87	3.54	2.20	5.78	8.39	100.00

Table A.9b Significant wave height and peak period frequency distribution at the nearshore location 4 (x= 290070 m,y= 4003012 m, all year, without the scheme).

Significant wave height (m)	Und.	-7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
		Mean wave direction (degrees N)																							
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.05	0.02	1.65	1.53	4.32	12.53	4.33	4.83	6.09	8.44	1.37	0.18	0.06	0.05	0.11	0.08	0.09	0.14	-	-	0.01	-	45.90
0.25: 0.75	.	-	-	-	-	2.92	2.10	12.06	8.95	0.13	0.06	0.23	2.04	3.84	0.72	0.58	0.15	-	-	-	0.06	-	-	-	-	33.82
0.75: 1.25	.	-	-	-	-	-	0.11	0.98	10.93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.01
1.25: 1.75	.	-	-	-	-	-	-	1.73	3.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.07
1.75: 2.25	.	-	-	-	-	-	-	0.73	1.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.95
2.25: 2.75	.	-	-	-	-	-	-	0.46	0.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.67
2.75: 3.25	.	-	-	-	-	-	-	0.24	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.26
3.25: 3.75	.	-	-	-	-	-	-	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19
3.75: 4.25	.	-	-	-	-	-	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.05	0.02	4.57	3.74	20.86	37.19	4.46	4.89	6.31	10.48	5.20	0.90	0.64	0.20	0.11	0.08	0.09	0.20	-	-	0.01	-	100.00

Table A.10a Significant wave height and mean wave direction frequency distribution at the nearshore location 5 (x= 290190 m,y= 4003650 m, all year, without the scheme).

Significant wave heigth (m)	Und.	<3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
		Peak period (s)											
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.24	3.22	6.60	7.10	5.24	3.82	2.78	2.02	1.62	5.16	7.09	45.90
0.25: 0.75	.	5.61	5.10	5.76	4.67	4.31	4.03	1.54	0.92	0.47	0.78	0.64	33.82
0.75: 1.25	.	0.10	0.17	0.80	2.60	3.04	3.55	0.98	0.46	0.13	0.11	0.08	12.01
1.25: 1.75	.	-	0.04	0.24	1.41	2.54	0.70	0.08	0.04	-	0.01	-	5.07
1.75: 2.25	.	-	-	0.04	0.23	0.83	0.76	0.07	-	-	0.01	0.01	1.95
2.25: 2.75	.	-	-	-	-	0.21	0.38	0.07	-	-	0.01	-	0.67
2.75: 3.25	.	-	-	-	-	0.01	0.14	0.10	0.01	-	0.01	-	0.26
3.25: 3.75	.	-	-	-	-	-	0.06	0.12	0.01	-	-	-	0.19
3.75: 4.25	.	-	-	-	-	-	-	0.06	0.07	-	-	-	0.13
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.95	8.52	13.45	16.01	16.19	13.44	5.79	3.52	2.22	6.09	7.82	100.00

Table A.10b Significant wave height and peak period frequency distribution at the nearshore location 5 (x= 290190 m,y= 4003650 m, all year, without the scheme).

Significant wave height (m)	Und.	Mean wave direction (degrees N) -7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.03	0.01	1.41	0.83	2.49	14.24	4.29	6.32	12.41	3.67	0.09	0.09	0.05	0.05	0.09	0.06	0.08	0.04	-	0.01	0.01	0.01	46.28
0.25: 0.75	.	-	-	-	-	2.98	2.21	12.10	9.36	0.21	0.40	1.71	3.27	0.93	0.22	-	-	-	0.02	0.09	0.12	-	-	-	-	33.62
0.75: 1.25	.	-	-	-	-	-	0.10	1.32	10.71	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.15
1.25: 1.75	.	-	-	-	-	-	0.02	2.23	2.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.92
1.75: 2.25	.	-	-	-	-	-	-	0.79	1.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.89
2.25: 2.75	.	-	-	-	-	-	-	0.47	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.66
2.75: 3.25	.	-	-	-	-	-	-	0.16	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21
3.25: 3.75	.	-	-	-	-	-	-	0.21	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.06	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.03	0.01	4.39	3.16	19.83	38.33	4.49	6.72	14.14	6.94	1.02	0.30	0.05	0.05	0.09	0.08	0.17	0.16	-	0.01	0.01	0.01	100.00

Table A.11a Significant wave height and mean wave direction frequency distribution at the nearshore location 1 (x= 289835 m, y= 4001580 m, all year, with the scheme).

Significant wave height (m)	Und.	Peak period (s) <3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.11	2.85	5.44	6.81	6.78	4.27	2.93	2.06	1.58	4.90	7.55	46.28
0.25: 0.75	.	4.94	4.27	5.56	4.70	5.08	4.43	1.65	0.90	0.50	0.82	0.77	33.62
0.75: 1.25	.	0.12	0.17	0.84	2.66	3.18	3.48	0.94	0.45	0.13	0.10	0.09	12.15
1.25: 1.75	.	-	0.03	0.23	1.36	2.46	0.71	0.08	0.04	-	0.02	-	4.92
1.75: 2.25	.	-	-	0.02	0.18	0.79	0.79	0.08	-	-	0.02	0.01	1.89
2.25: 2.75	.	-	-	-	-	0.17	0.39	0.09	0.01	-	-	-	0.66
2.75: 3.25	.	-	-	-	-	0.01	0.09	0.09	0.01	-	0.01	-	0.21
3.25: 3.75	.	-	-	-	-	-	0.05	0.15	0.02	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.02	0.05	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.16	7.31	12.08	15.70	18.46	14.22	6.02	3.54	2.21	5.87	8.42	100.00

Table A.11b Significant wave height and peak period frequency distribution at the nearshore location 1 (x= 289835 m, y= 4001580 m, all year, with the scheme).

Significant wave height (m)	Und.	Mean wave direction (degrees N) -7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.01	0.02	1.43	0.75	2.77	14.25	4.32	6.51	11.70	3.62	0.16	0.08	0.07	0.12	0.10	0.08	0.04	0.01	0.01	-	0.02	-	46.07
0.25: 0.75	.	-	-	-	-	3.00	2.35	12.14	9.04	0.19	0.18	1.09	3.68	1.31	0.39	0.02	-	0.02	0.07	0.12	-	-	-	-	-	33.59
0.75: 1.25	.	-	-	-	-	-	0.10	1.16	10.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.14
1.25: 1.75	.	-	-	-	-	-	0.02	2.27	2.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.02
1.75: 2.25	.	-	-	-	-	-	-	0.93	1.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.99
2.25: 2.75	.	-	-	-	-	-	-	0.43	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	-	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.25
3.25: 3.75	.	-	-	-	-	-	-	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.01	0.02	4.43	3.22	20.27	38.15	4.50	6.68	12.79	7.30	1.47	0.47	0.09	0.12	0.12	0.15	0.16	0.01	0.01	-	0.02	-	100.00

Table A.12a Significant wave height and mean wave direction frequency distribution at the nearshore location 2 (x= 289912 m, y= 4001954 m, all year, with the scheme).

Significant wave height (m)	Und.	Peak period (s) <3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.12	3.02	5.69	6.93	6.24	4.01	2.90	2.06	1.58	4.92	7.60	46.07
0.25: 0.75	.	5.06	4.30	5.56	4.70	4.87	4.31	1.84	0.91	0.50	0.80	0.73	33.59
0.75: 1.25	.	0.13	0.17	0.84	2.61	3.09	3.52	0.96	0.48	0.14	0.12	0.09	12.14
1.25: 1.75	.	-	0.04	0.22	1.40	2.53	0.69	0.08	0.04	-	0.02	-	5.02
1.75: 2.25	.	-	-	0.04	0.23	0.82	0.79	0.08	-	-	0.02	0.01	1.99
2.25: 2.75	.	-	-	-	-	0.19	0.38	0.06	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	0.01	0.12	0.11	0.01	-	0.01	-	0.25
3.25: 3.75	.	-	-	-	-	-	0.06	0.15	0.03	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.03	0.05	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.30	7.53	12.35	15.86	17.76	13.89	6.19	3.58	2.21	5.89	8.43	100.00

Table A.12b Significant wave height and peak period frequency distribution at the nearshore location 2 (x= 289912 m, y= 4001954 m, all year, with the scheme).

Significant wave height (m)	Und.	Mean wave direction (degrees N) -7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	0.01	0.03	0.15	0.12	1.63	0.94	3.86	13.75	5.37	6.29	10.89	4.49	0.05	0.03	0.02	0.02	0.01	0.02	0.03	0.02	-	0.01	0.03	-	47.76
0.25: 0.75	.	-	-	-	-	3.09	2.45	11.80	9.16	0.16	0.08	2.20	2.69	0.41	0.02	-	-	-	-	-	-	-	-	-	-	32.05
0.75: 1.25	.	-	-	-	-	-	0.11	1.14	10.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.13
1.25: 1.75	.	-	-	-	-	-	0.01	1.85	3.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.96
1.75: 2.25	.	-	-	-	-	-	-	0.76	1.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.94
2.25: 2.75	.	-	-	-	-	-	-	0.44	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.64
2.75: 3.25	.	-	-	-	-	-	-	0.19	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.25: 3.75	.	-	-	-	-	-	-	0.22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	0.01	0.03	0.15	0.12	4.73	3.50	20.34	38.29	5.53	6.37	13.09	7.18	0.46	0.05	0.02	0.02	0.01	0.02	0.03	0.02	-	0.01	0.03	-	100.00

Table A.13a Significant wave height and mean wave direction frequency distribution at the nearshore location 3 (x= 290002 m, y= 4002503 m, all year, with the scheme).

Significant wave height (m)	Und.	Peak period (s) <3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.22	3.15	5.83	7.39	6.66	4.21	2.94	2.09	1.58	4.94	7.75	47.76
0.25: 0.75	.	4.95	4.16	5.42	4.29	4.43	4.18	1.81	0.92	0.51	0.78	0.61	32.05
0.75: 1.25	.	0.12	0.18	0.86	2.76	3.15	3.50	0.85	0.42	0.12	0.10	0.08	12.13
1.25: 1.75	.	-	0.03	0.23	1.36	2.50	0.71	0.07	0.03	-	0.02	-	4.96
1.75: 2.25	.	-	-	0.02	0.21	0.80	0.80	0.08	-	0.01	0.01	0.01	1.94
2.25: 2.75	.	-	-	-	-	0.17	0.38	0.08	-	-	0.01	-	0.64
2.75: 3.25	.	-	-	-	-	0.01	0.11	0.10	0.01	-	-	-	0.23
3.25: 3.75	.	-	-	-	-	-	0.05	0.14	0.03	-	-	-	0.22
3.75: 4.25	.	-	-	-	-	-	-	0.02	0.05	-	-	-	0.07
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.29	7.51	12.37	16.00	17.73	13.94	6.09	3.55	2.22	5.86	8.44	100.00

Table A.13b Significant wave height and peak period frequency distribution at the nearshore location 3 (x= 290002 m, y= 4002503 m, all year, with the scheme).

		Mean wave direction (degrees N)																								
Significant		-7.5	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	
wave height (m)	Und.	7.5	22.5	37.5	52.5	67.5	82.5	97.5	112.5	127.5	142.5	157.5	172.5	187.5	202.5	217.5	232.5	247.5	262.5	277.5	292.5	307.5	322.5	337.5	352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	0.01	0.01	0.02	0.04	1.50	1.07	4.41	13.05	4.48	5.28	10.65	6.99	0.09	0.07	0.05	0.07	0.05	0.07	0.08	0.12	0.11	0.01	0.01	-	48.22
0.25: 0.75	.	-	-	-	-	3.06	2.38	11.75	9.31	0.13	0.08	1.02	2.05	0.96	0.73	0.21	0.02	-	-	-	-	0.11	0.02	-	-	31.83
0.75: 1.25	.	-	-	-	-	-	0.11	1.14	10.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.96
1.25: 1.75	.	-	-	-	-	-	0.01	1.80	3.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.93
1.75: 2.25	.	-	-	-	-	-	-	0.75	1.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.91
2.25: 2.75	.	-	-	-	-	-	-	0.43	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	-	-	0.20	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.25: 3.75	.	-	-	-	-	-	-	0.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	0.01	0.01	0.02	0.04	4.56	3.56	20.79	37.57	4.61	5.36	11.67	9.04	1.05	0.80	0.25	0.09	0.05	0.07	0.08	0.12	0.22	0.03	0.01	-	100.00

Table A.14a Significant wave height and mean wave direction frequency distribution at the nearshore location 4 (x= 290070 m, y= 4003012 m, all year, with the scheme).

		Peak period (s)											
Significant		<3	3	4	5	6	7	8	9	10	11	>13.5	
wave height (m)	Und.		4	5	6	7	8	9	10	11	13.5		Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.21	3.31	6.06	7.36	6.79	4.18	2.91	2.12	1.60	4.93	7.76	48.22
0.25: 0.75	.	5.21	4.70	5.66	4.01	3.89	4.00	1.69	0.90	0.48	0.73	0.55	31.83
0.75: 1.25	.	0.12	0.17	0.85	2.75	3.17	3.45	0.78	0.40	0.10	0.09	0.08	11.96
1.25: 1.75	.	-	0.03	0.23	1.35	2.48	0.72	0.07	0.03	0.01	0.01	-	4.93
1.75: 2.25	.	-	-	0.02	0.20	0.79	0.79	0.08	-	0.01	0.01	0.01	1.91
2.25: 2.75	.	-	-	-	-	0.17	0.38	0.08	-	-	-	-	0.63
2.75: 3.25	.	-	-	-	-	0.01	0.10	0.10	0.01	-	0.01	-	0.23
3.25: 3.75	.	-	-	-	-	-	0.06	0.14	0.03	-	-	-	0.23
3.75: 4.25	.	-	-	-	-	-	-	0.03	0.05	-	-	-	0.08
4.25: 4.75	.	-	-	-	-	-	-	-	-	-	-	-	-
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.55	8.20	12.82	15.66	17.30	13.69	5.87	3.54	2.20	5.78	8.39	100.00

Table A.14b Significant wave height and peak period frequency distribution at the nearshore location 4 (x= 290070 m, y= 4003012 m, all year, with the scheme).

Significant wave height (m)	Und.	Mean wave direction (degrees N) -7.5 7.5	7.5 22.5	22.5 37.5	37.5 52.5	52.5 67.5	67.5 82.5	82.5 97.5	97.5 112.5	112.5 127.5	127.5 142.5	142.5 157.5	157.5 172.5	172.5 187.5	187.5 202.5	202.5 217.5	217.5 232.5	232.5 247.5	247.5 262.5	262.5 277.5	277.5 292.5	292.5 307.5	307.5 322.5	322.5 337.5	337.5 352.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	-	0.02	0.05	0.02	1.65	1.48	4.35	12.48	4.48	4.81	6.11	8.39	1.35	0.18	0.06	0.04	0.10	0.08	0.11	0.14	-	0.01	0.01	-	45.93
0.25: 0.75	.	-	-	-	-	2.92	2.10	12.04	8.95	0.13	0.06	0.23	2.07	3.84	0.68	0.61	0.12	-	-	-	0.06	-	-	-	-	33.80
0.75: 1.25	.	-	-	-	-	-	0.11	0.98	10.93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.01
1.25: 1.75	.	-	-	-	-	-	-	1.79	3.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.06
1.75: 2.25	.	-	-	-	-	-	-	0.73	1.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.95
2.25: 2.75	.	-	-	-	-	-	-	0.46	0.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.67
2.75: 3.25	.	-	-	-	-	-	-	0.24	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.26
3.25: 3.75	.	-	-	-	-	-	-	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19
3.75: 4.25	.	-	-	-	-	-	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	-	0.02	0.05	0.02	4.57	3.69	20.93	37.07	4.61	4.87	6.35	10.47	5.19	0.85	0.67	0.16	0.10	0.08	0.11	0.20	-	0.01	0.01	-	100.00

Table A.15a Significant wave height and mean wave direction frequency distribution at the nearshore location 5 (x= 290190 m, y= 4003650 m, all year, with the scheme).

Significant wave height (m)	Und.	Peak period (s) <3	3 4	4 5	5 6	6 7	7 8	8 9	9 10	10 11	11 13.5	>13.5	Total
Undetermined	.	.	.	.	.	.	.	.	.	.	.	.	.
< 0.25	.	1.24	3.24	6.61	7.10	5.25	3.81	2.78	2.02	1.62	5.17	7.08	45.93
0.25: 0.75	.	5.61	5.10	5.74	4.66	4.31	4.04	1.54	0.92	0.47	0.78	0.64	33.80
0.75: 1.25	.	0.10	0.17	0.80	2.60	3.05	3.54	0.98	0.46	0.13	0.11	0.08	12.01
1.25: 1.75	.	-	0.04	0.24	1.41	2.53	0.70	0.08	0.04	-	0.01	-	5.06
1.75: 2.25	.	-	-	0.04	0.23	0.83	0.76	0.07	-	-	0.01	0.01	1.95
2.25: 2.75	.	-	-	-	-	0.21	0.38	0.07	-	-	0.01	-	0.67
2.75: 3.25	.	-	-	-	-	0.01	0.14	0.10	0.01	-	0.01	-	0.26
3.25: 3.75	.	-	-	-	-	-	0.06	0.12	0.01	-	-	-	0.19
3.75: 4.25	.	-	-	-	-	-	-	0.06	0.07	-	-	-	0.13
4.25: 4.75	.	-	-	-	-	-	-	0.01	-	-	-	-	0.01
4.75: 5.25	.	-	-	-	-	-	-	-	-	-	-	-	-
5.25: 5.75	.	-	-	-	-	-	-	-	-	-	-	-	-
5.75: 6.25	.	-	-	-	-	-	-	-	-	-	-	-	-
Total	.	6.95	8.54	13.44	16.00	16.20	13.43	5.79	3.52	2.22	6.10	7.81	100.00

Table A.15b Significant wave height and peak period frequency distribution at the nearshore location 5 (x= 290190 m, y= 4003650 m, all year, with the scheme).