measurements that show high biomass in the more brackish parts. The NN results show higher biomass in shallower areas and lower biomass in deeper areas, which is comparable to the measurements. The predicted patterns for the western part of the Westerschelde however, look very suspicious, and do not seem to fit the measurements very well. These patterns may be the result of the gradients in depth, median grainsize and current velocity, or a combination of both. Finally, for some regions the NN predicts biomass values that are larger than 1.04, while it was trained on values between 0.0 and 1.04; these predictions are incorrect.

4.5.12 Conclusions and Discussion

The extensive data set for the Westerschelde does not give away a clear correlation between local abiotic conditions and the abundance and distribution of macrozoobenthos. The neural networks behave relatively bad due to the fact that they are faced with a lot of ambiguous data (at any combination of abiotic parameters a very high biomass as well as a very low biomass can occur). Apparently the available parameters are not explaining all the variety and heterogeneity in biomass in the Westerschelde.

Results of the Principal Component Analysis on the abiotic data reveal that the variables depth, ebb-velocity, median grainsize and salinity are dependent of each other, but their correlation is not large.

A set of neural network runs with different configurations were applied on the data for total biomass, using all available data for training. All network configurations suffered from underestimation of the output. Best results were obtained with a hidden layer of eight neurons and an exponential transfer function on the output neuron. Correlation between target and NN output was 0.81. Increasing the number of hidden neurons will help to improve the correlation on the training set, but then the network is more or less 'specialised' on this dataset, and is no longer able to generalise anymore. The networks with linear transfer functions showed bad results. Therefore, a multivariate linear regression cannot not be applied.

Subsequently, the data set was divided into a randomly chosen training set of 900 samples and a testing set of 449 samples. The correlation coefficient for training was 0.83, for testing 0.65. Limiting the number of input neurons by omitting the sample month as input did not give a worse correlation (0.83 for training, 0.71 for testing). However, excluding the salinity as input parameter resulted a network that is not generally applicable in the Westerschelde (0.79 for training, 0.57 for testing).

Finally, the trained neural network was applied on a spatial grid that covered the complete Westerschelde. The predictions of the neural network were compared to the measurements of total biomass. It was concluded that the predicted patterns in the Westerschelde were not in compliance with the measurements.

5 Conclusions

Estuaries are highly dynamic environments, both in terms of natural processes and human activities. The sustainable development of estuaries therefore requires a sound knowledge of these dynamic processes. The ECOFLAT project tried to increase the body of knowledge of which the management of estuaries can benefit. One way of increasing insight into these processes is by developing models for the physical and biological environment. In this report the modelling efforts have been described with respect to the hydraulic and transport processes and to the prediction of macrobenthic fauna.

It can be concluded that the hydraulic model which was made for the intertidal area (Molenplaat) is able to reproduce the water levels and current velocities sufficiently accurate. The model has been used for describing the transport processes on the intertidal flat. The transport model uses physical processes only and proved to be capable of reproducing the concentrations in the water column and the sedimentation areas adequately. However, the yearly sedimentation rates (extrapolated from the net sedimentation rate for the month of June) proved to be somewhat lower than the estimate derived from the depth profiles of radionuclides (8mm and 1.3 cm, respectively). Furthermore, the spatial distribution of sedimentation as calculated from the model did not compare very well with the actual distribution of areas on the Molenplaat with high percentages of silt. One of the possible explanations to this could be that the dynamics of fine silt cannot be modelled adequately by physical processes only, biological processes may have a large impact on sediment dynamics.

Different methods have been used to predict macrobenthic distribution along the entire Westernscheldt estuary. Based on an extensive database of measurements, whereby macrobenthic biomass of various species has been correlated with environmental parameters (depth, median grainsize, salinity and maximum current velocity), models have been developed for predicting macrobenthic biomass. The conclusion was that this extensive set of data for the Westernscheldt does not give a clear correlation between local abiotic conditions and the abundance and distribution of macrozoobenthos. Apparently, the available environmental parameters are not explaining all the variety and heterogeneity in biomass in the Westerschelde.

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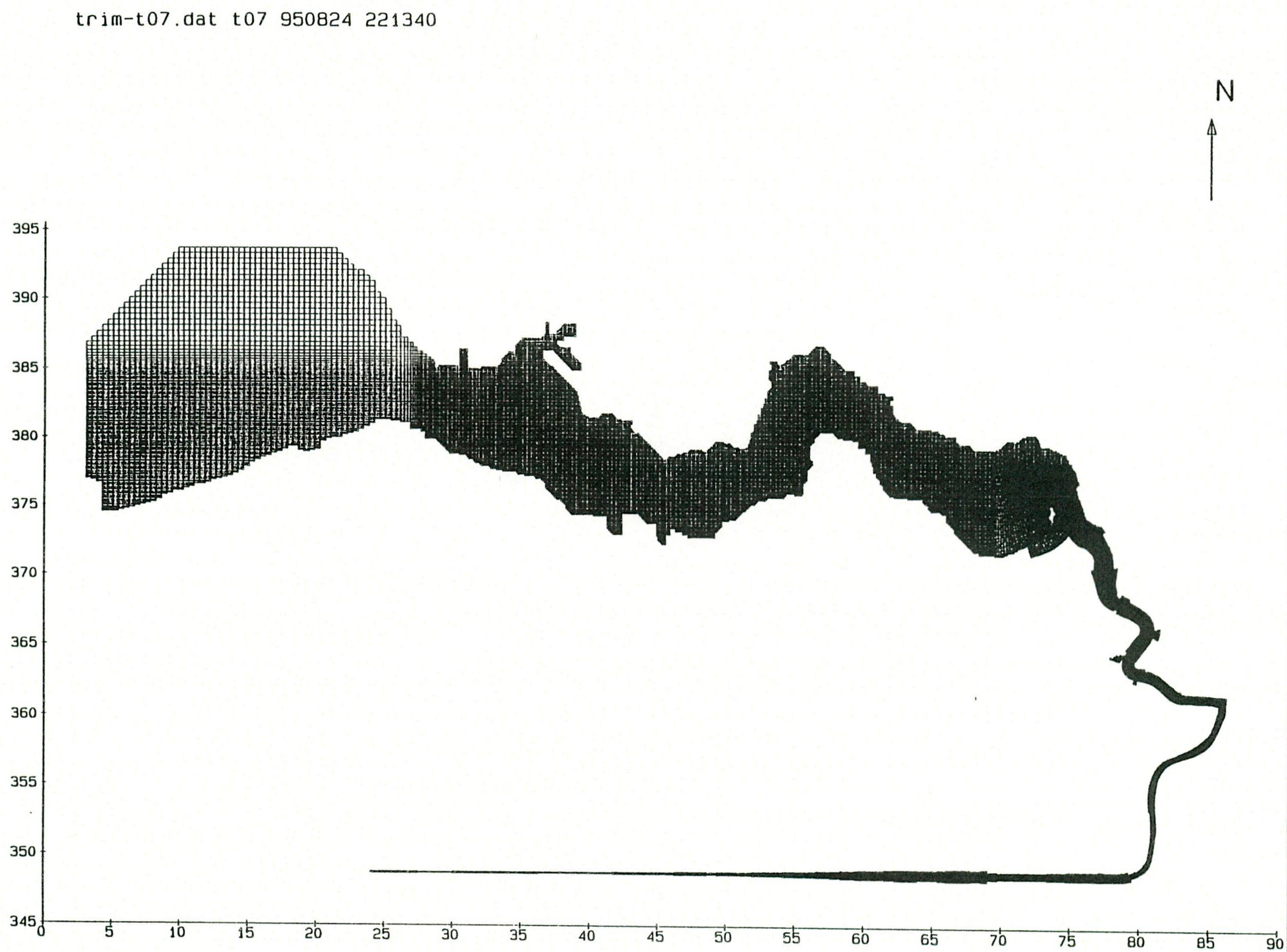
A Figures

SCALDIS Grid Schematisation



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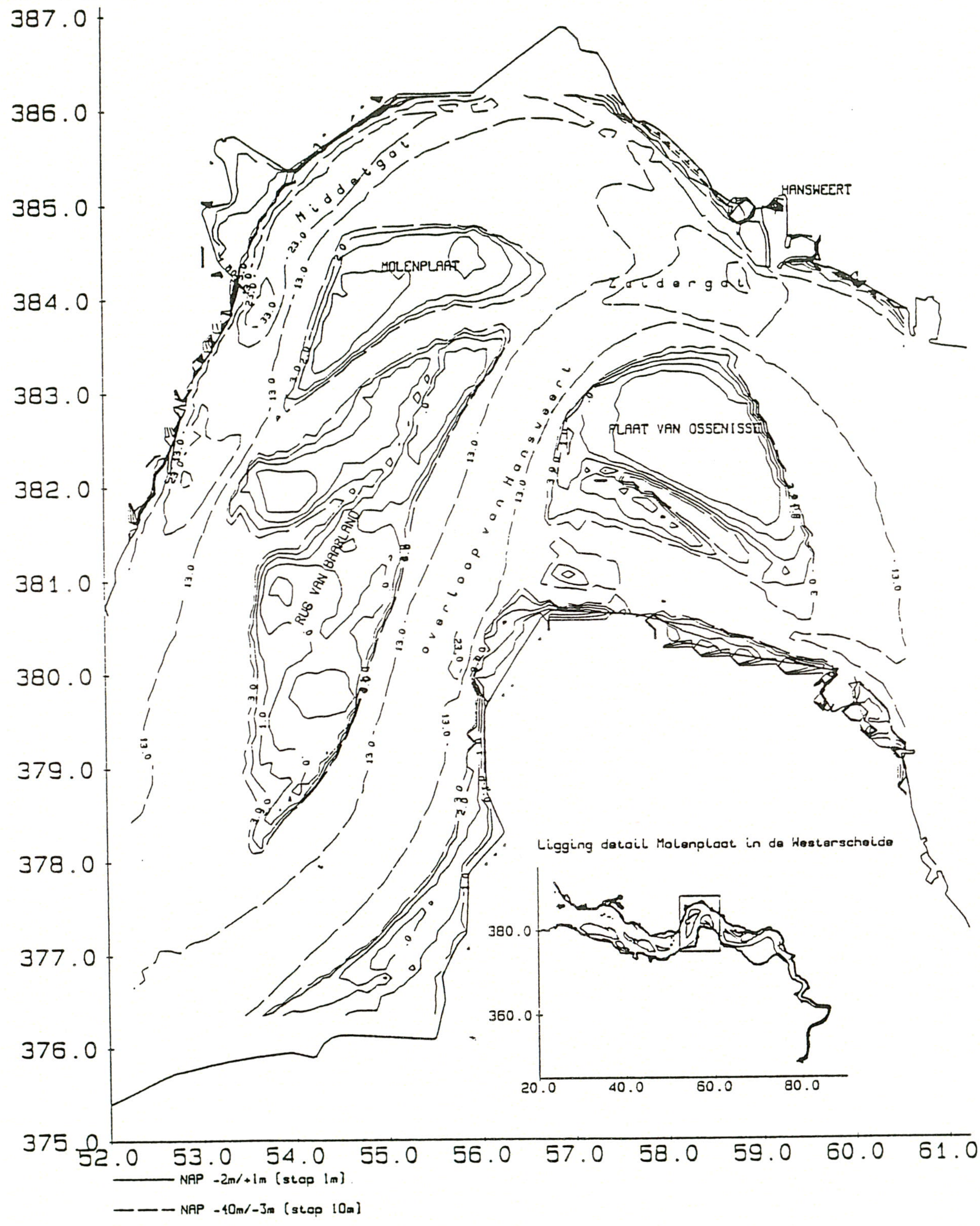
ECOFLAT

Fig. 2.1



Location of the Molenplaat in the Western Scheldt

ECOFLAT

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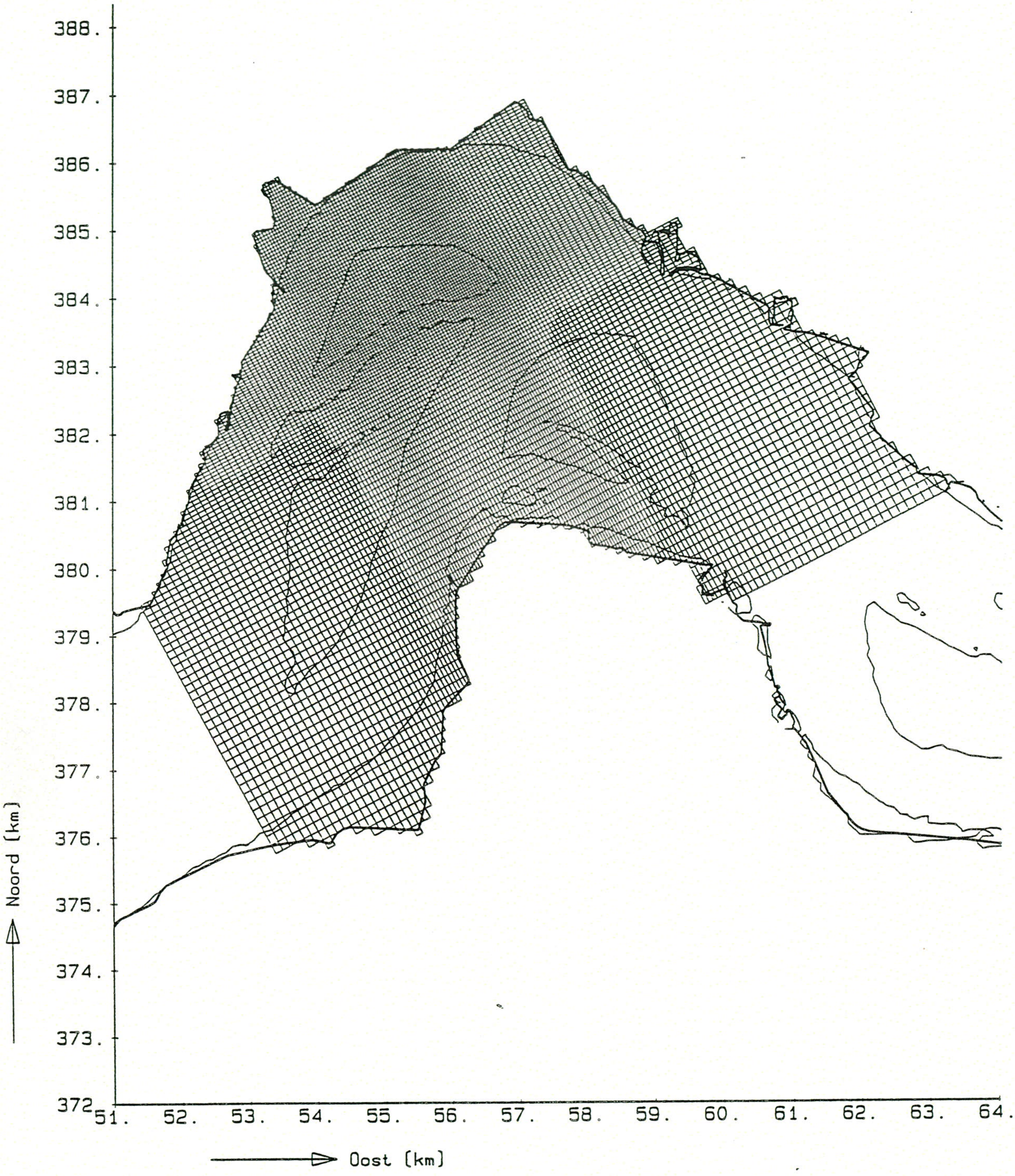
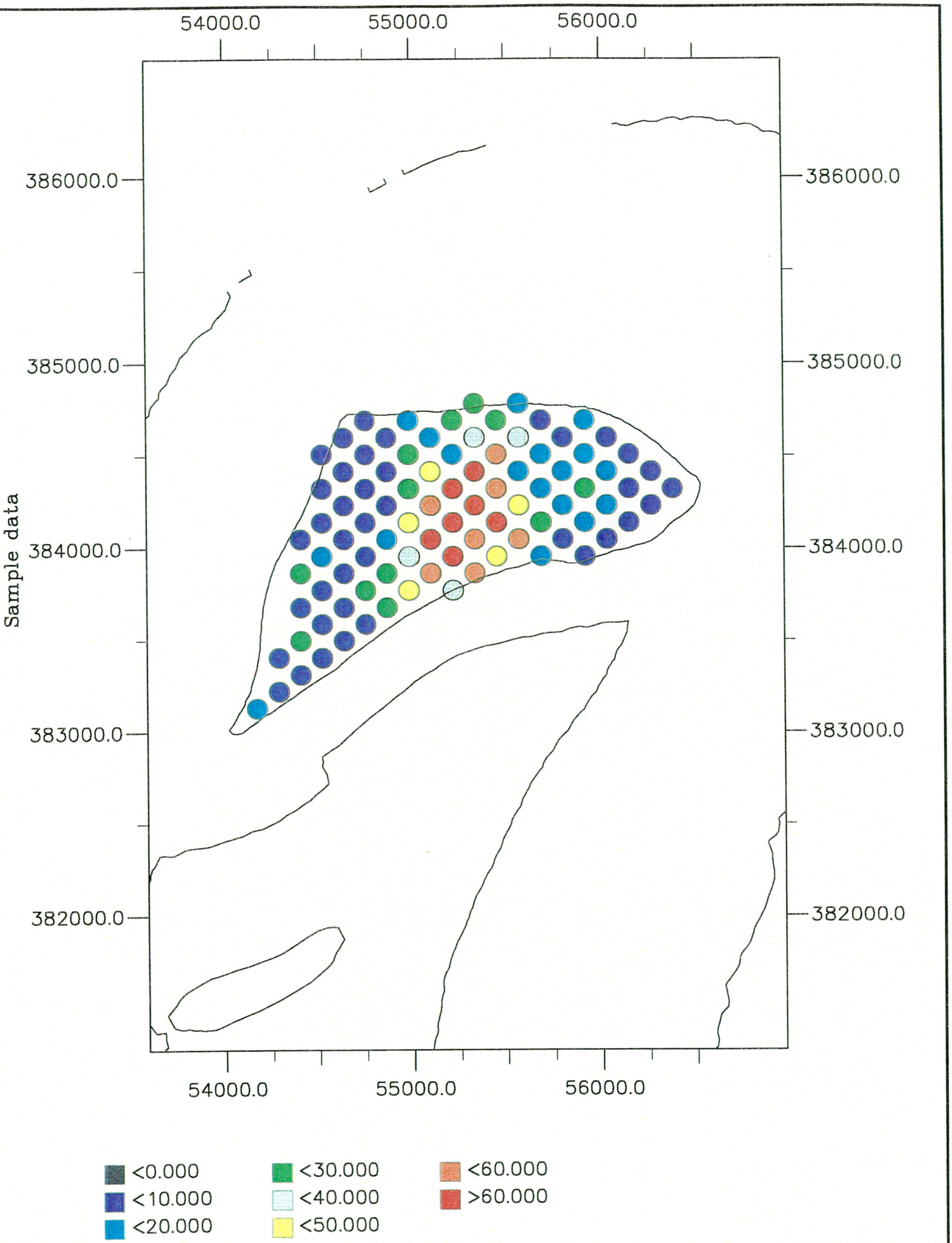
Fig. 2.2



Molenplaat grid schematisation	ECOFLAT
WL | delft hydraulics	Fig. 2.3



Measured percentages fine silt in Molenplaat sediment together with the 5 meter maximal depth isocontour		Figure 3.1
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Maximum water depth during a tidal cycle
and location of the monitoring points for time series
of suspended solids concentrations in the water column

Figure 3.2

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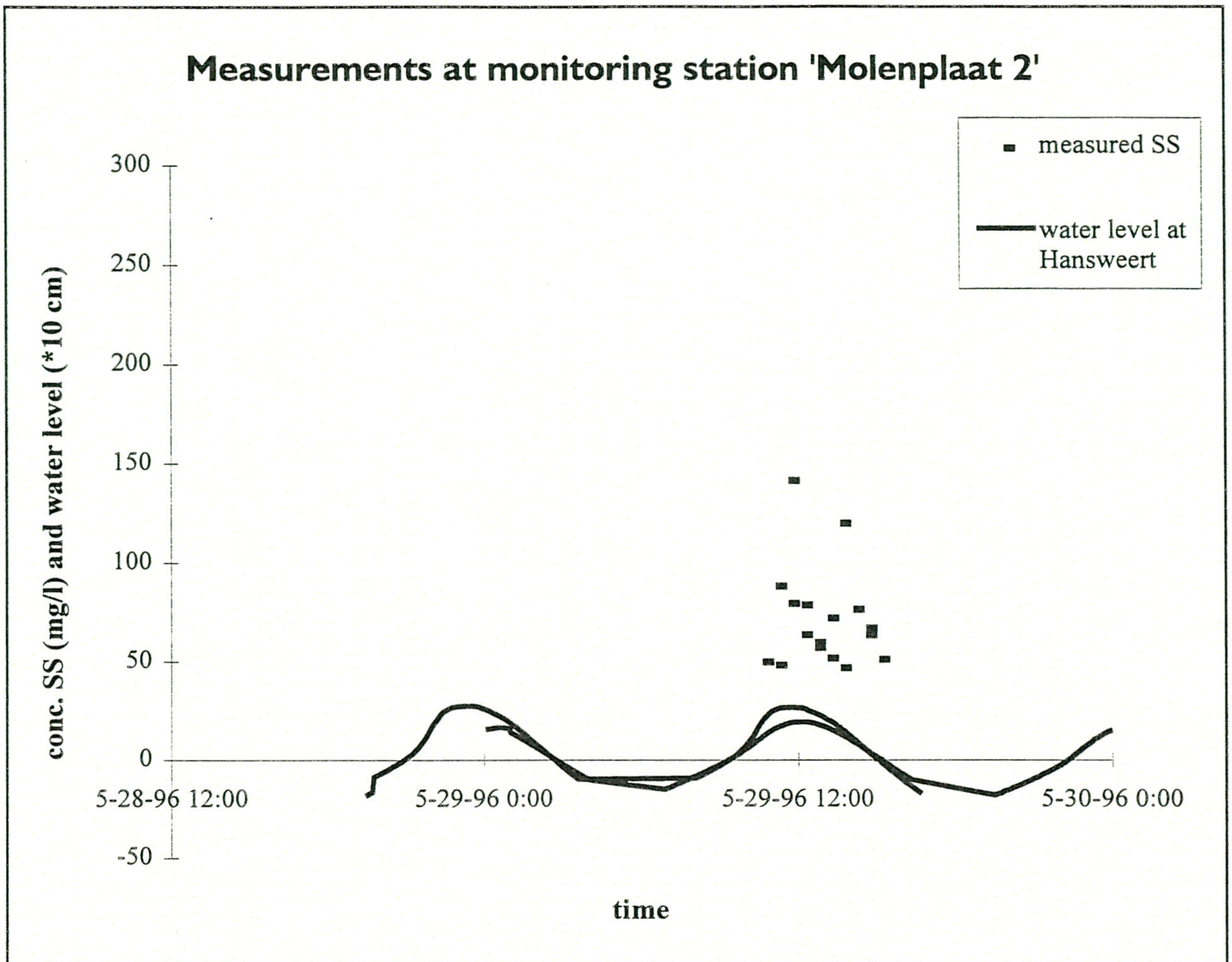
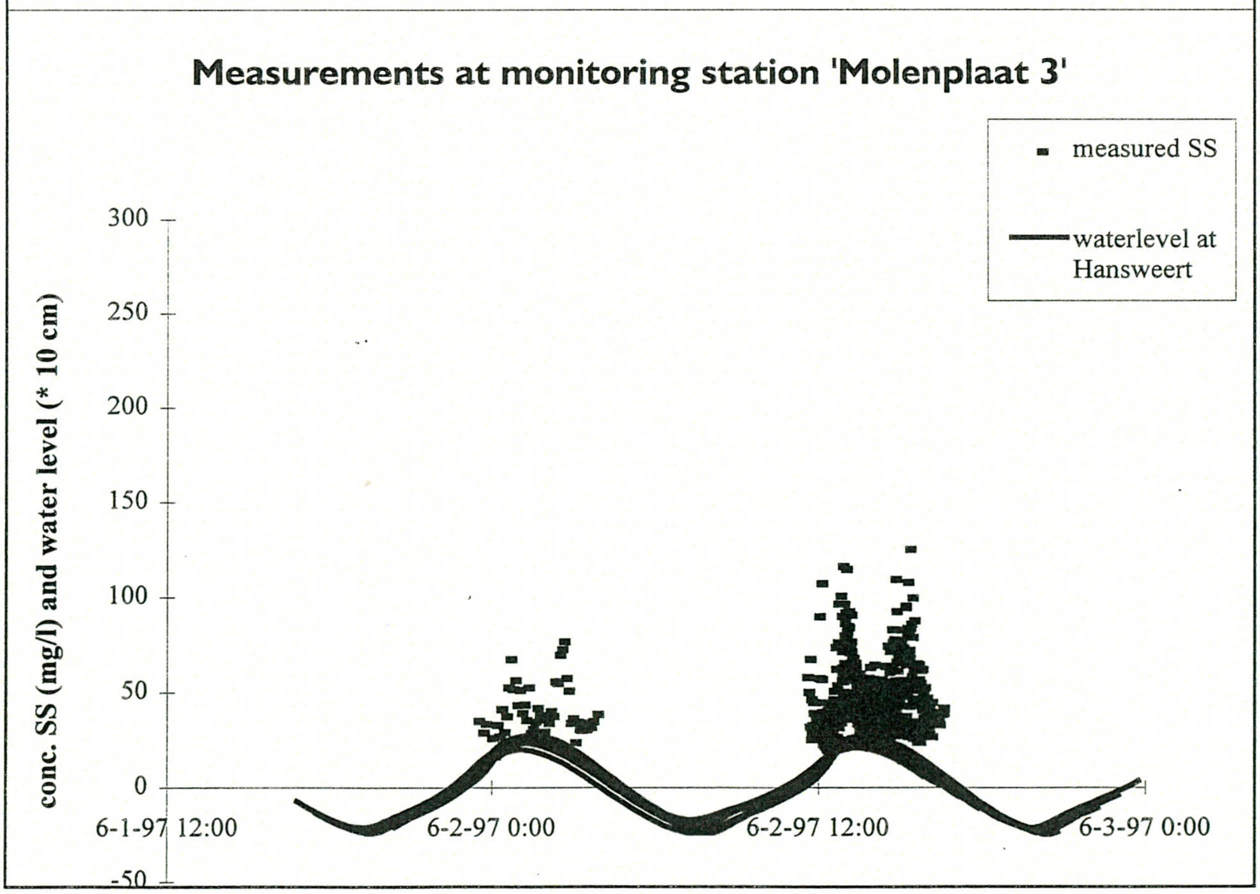
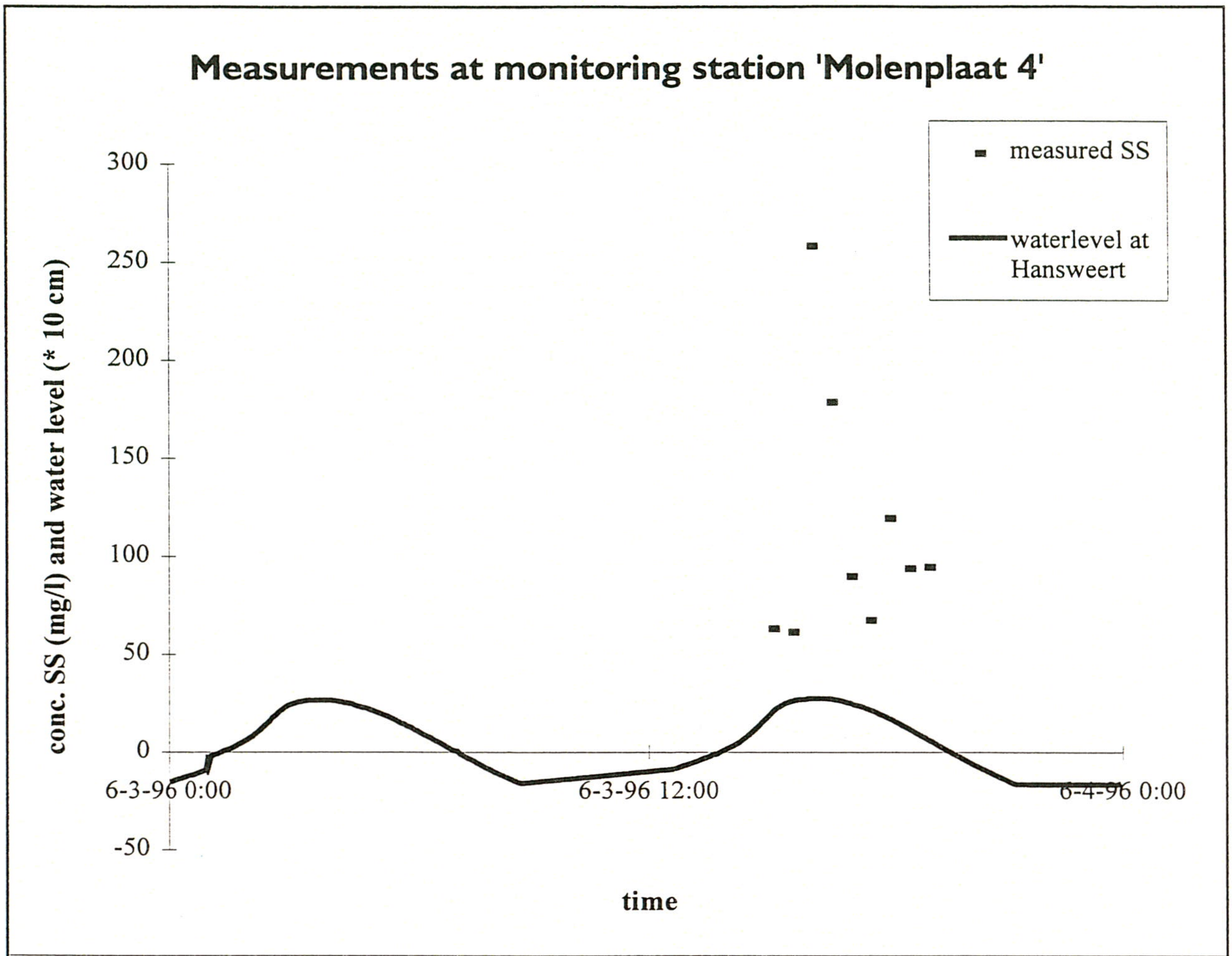
Figure 3.3


Measurements at monitoring station 'Molenplaat 2'
measured SS
water level at Hansweert
conc. SS (mg/l) and water level (*10 cm)
300
250
200
150
100
50
0
-50
5-28-96 12:00
5-29-96 0:00
5-29-96 12:00
5-30-96 0:00
time


Measurements at monitoring station 'Molenplaat 3'
measured SS
waterlevel at Hansweert
conc. SS (mg/l) and water level (* 10 cm)
300
250
200
150
100
50
0
-50
6-1-97 12:00
6-2-97 0:00
6-2-97 12:00
6-3-97 0:00


Measurements at monitoring station 'Molenplaat 4'
measured SS
waterlevel at Hansweert
conc. SS (mg/l) and water level (* 10 cm)
300
250
200
150
100
50
0
-50
6-3-96 0:00
6-3-96 12:00
6-4-96 0:00
time

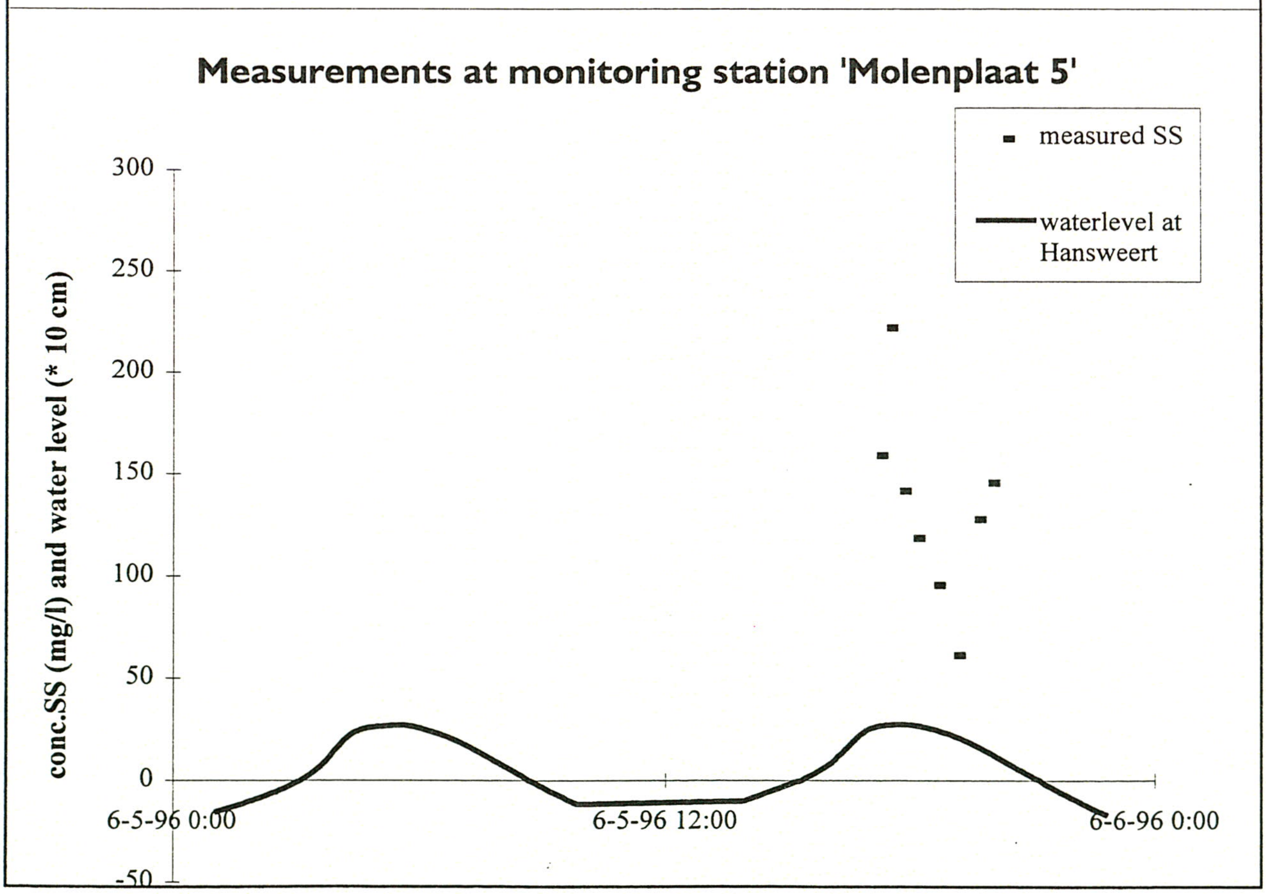
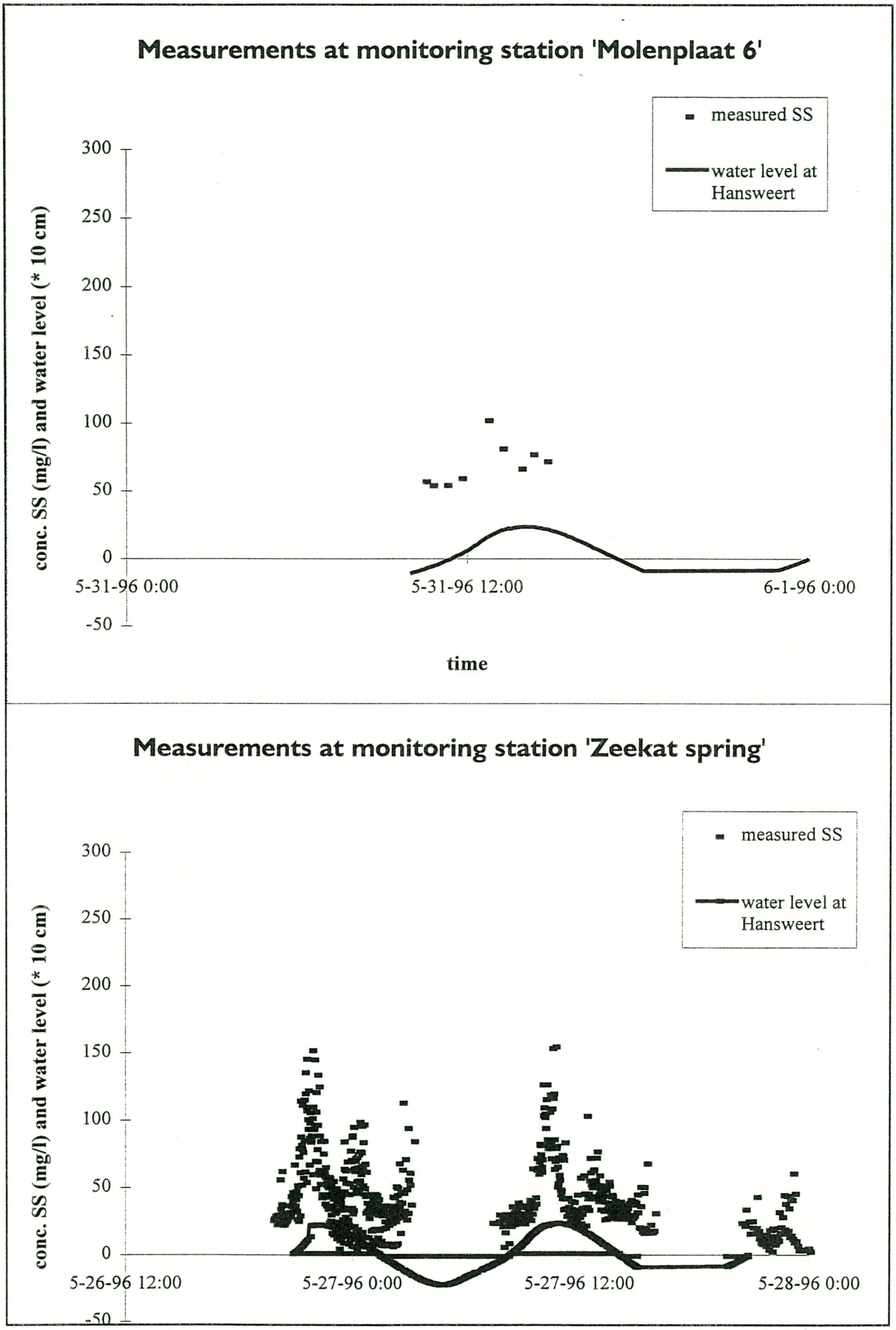
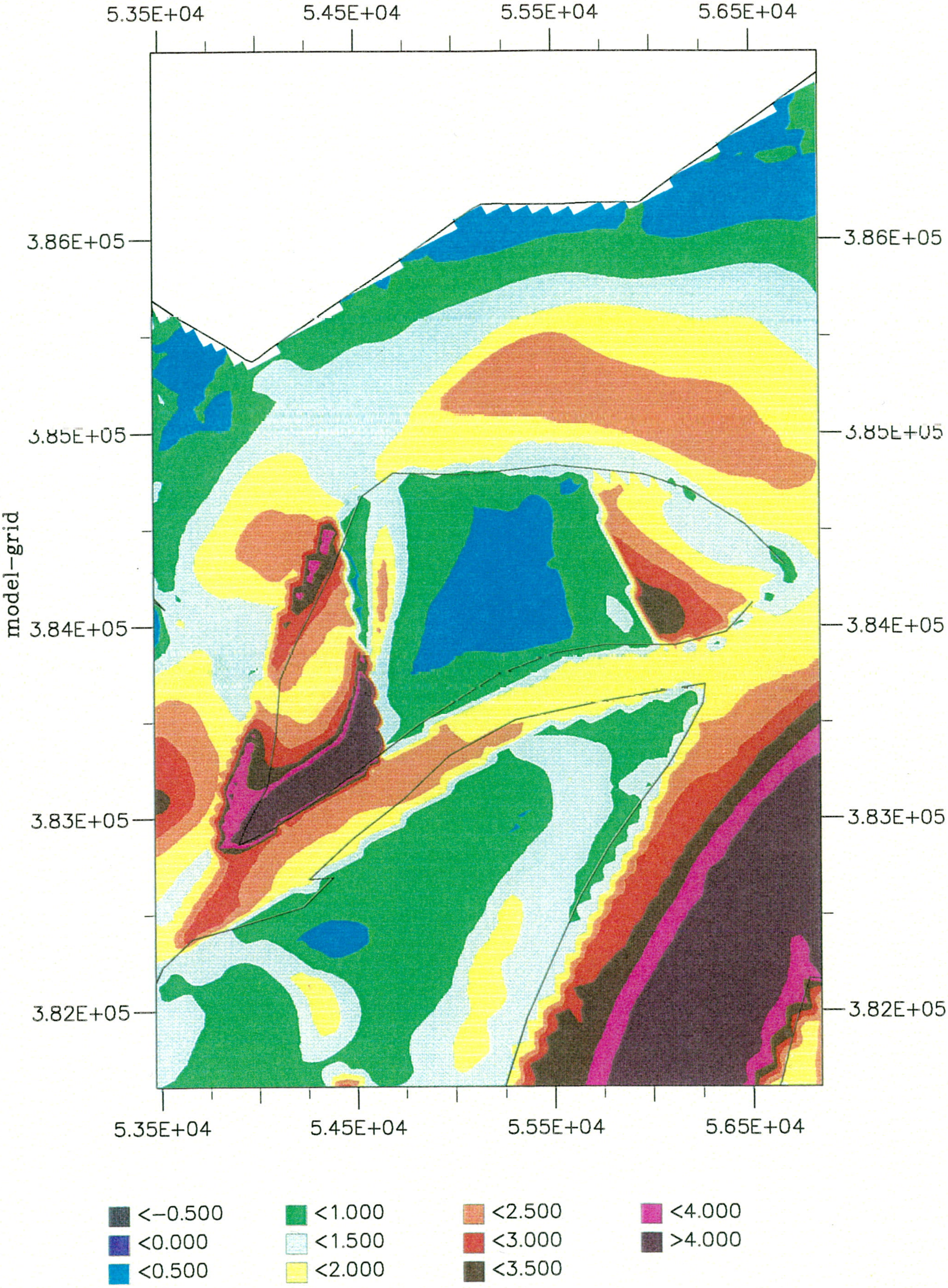

Measurements at monitoring station 'Molenplaat 5'
measured SS
waterlevel at Hansweert
conc.SS (mg/l) and water level (* 10 cm)
300
250
200
150
100
50
0
-50
6-5-96 0:00
6-5-96 12:00
6-6-96 0:00

Figure 3.5



Measurements at monitoring station 'Molenplaat 6'
measured SS
water level at Hansweert
conc. SS (mg/l) and water level (* 10 cm)
300
250
200
150
100
50
0
-50
5-31-96 0:00
5-31-96 12:00
6-1-96 0:00
time
Measurements at monitoring station 'Zeekat spring'
measured SS
water level at Hansweert
conc. SS (mg/l) and water level (* 10 cm)
300
250
200
150
100
50
0
-50
5-26-96 12:00
5-27-96 0:00
5-27-96 12:00
5-28-96 0:00



Maximum bottom shear stress during one tidal cycle

Figure 3.7

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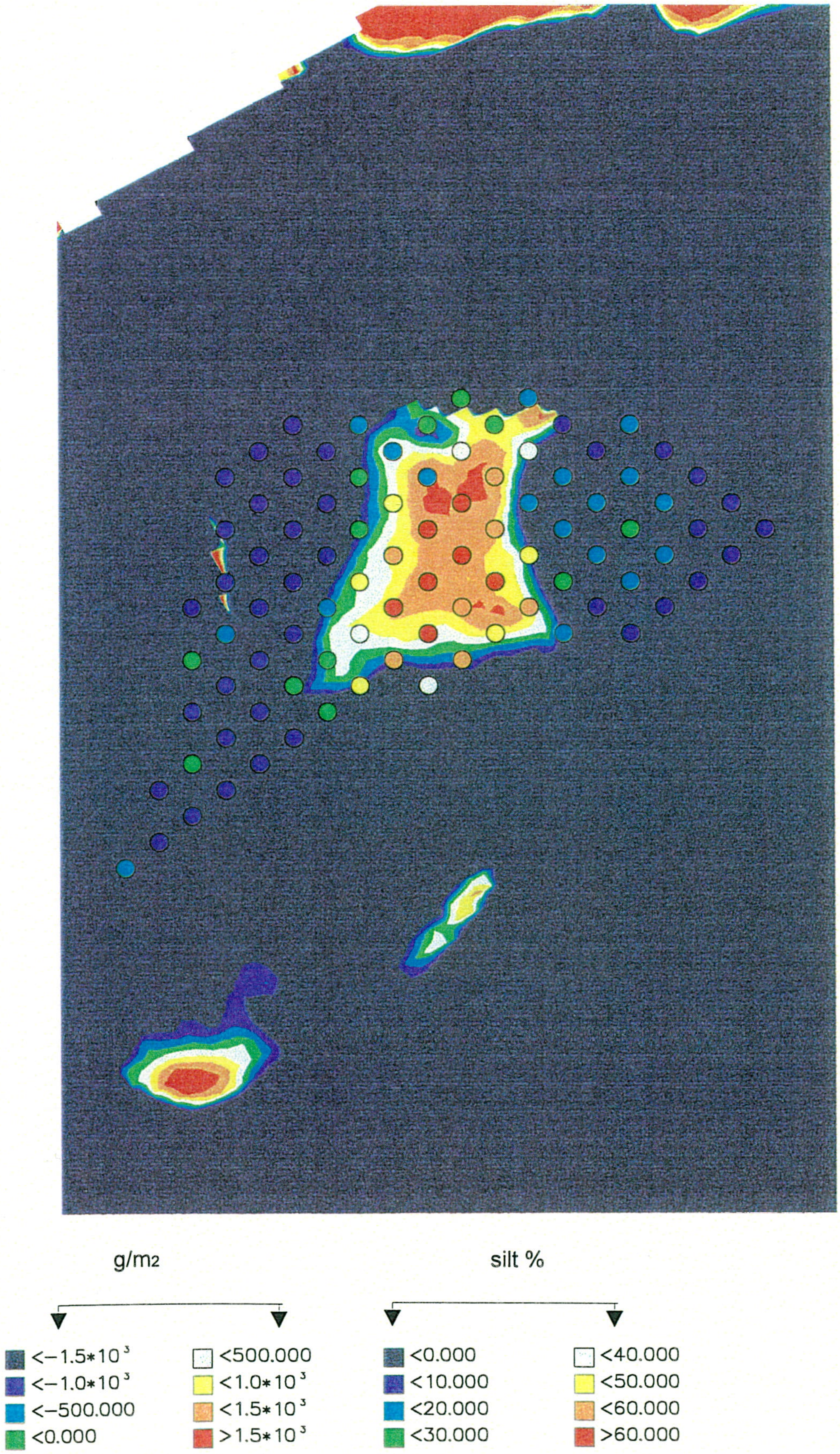

Cumulative net sedimentation flux (g/m2 in 20 days) and measured percentages of fine silt in the sediment
Vsed = 5, tres = 0.3, tsed = 0.1, Zres = 4320

Figure 3.9

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Time series of the suspended solids concentration
at monitoring station 'Zeekat spring'
VSed = 5, tauSed = 0.1, tauRes = 0.3, ZRes = 4.320

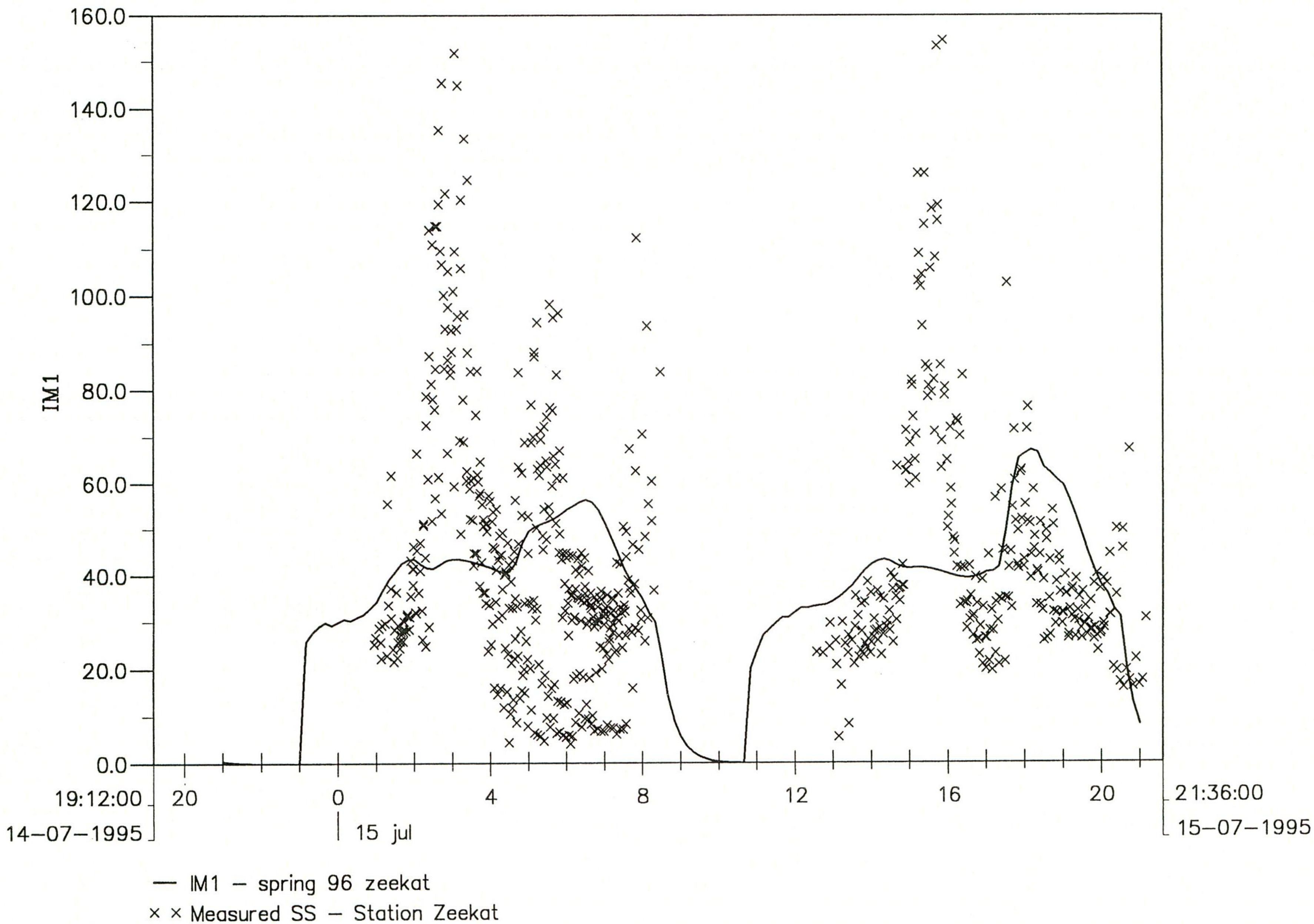

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Figure 3.10

Time series of the suspended solids concentration
at monitoring station 'Molenplaat 3'
VSed = 5, tauSed = 0.1, tauRes = 0.3, ZRes = 4320

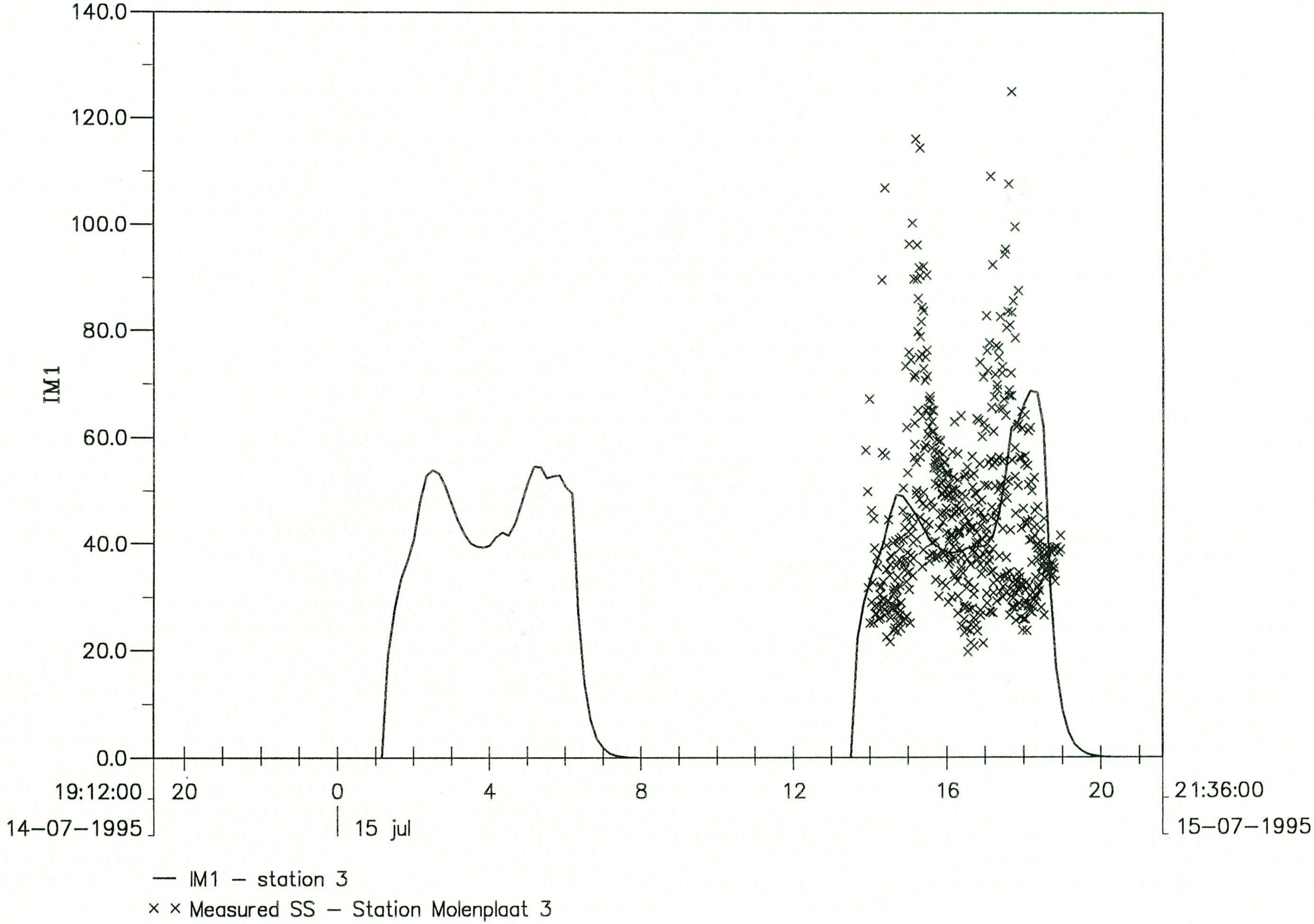

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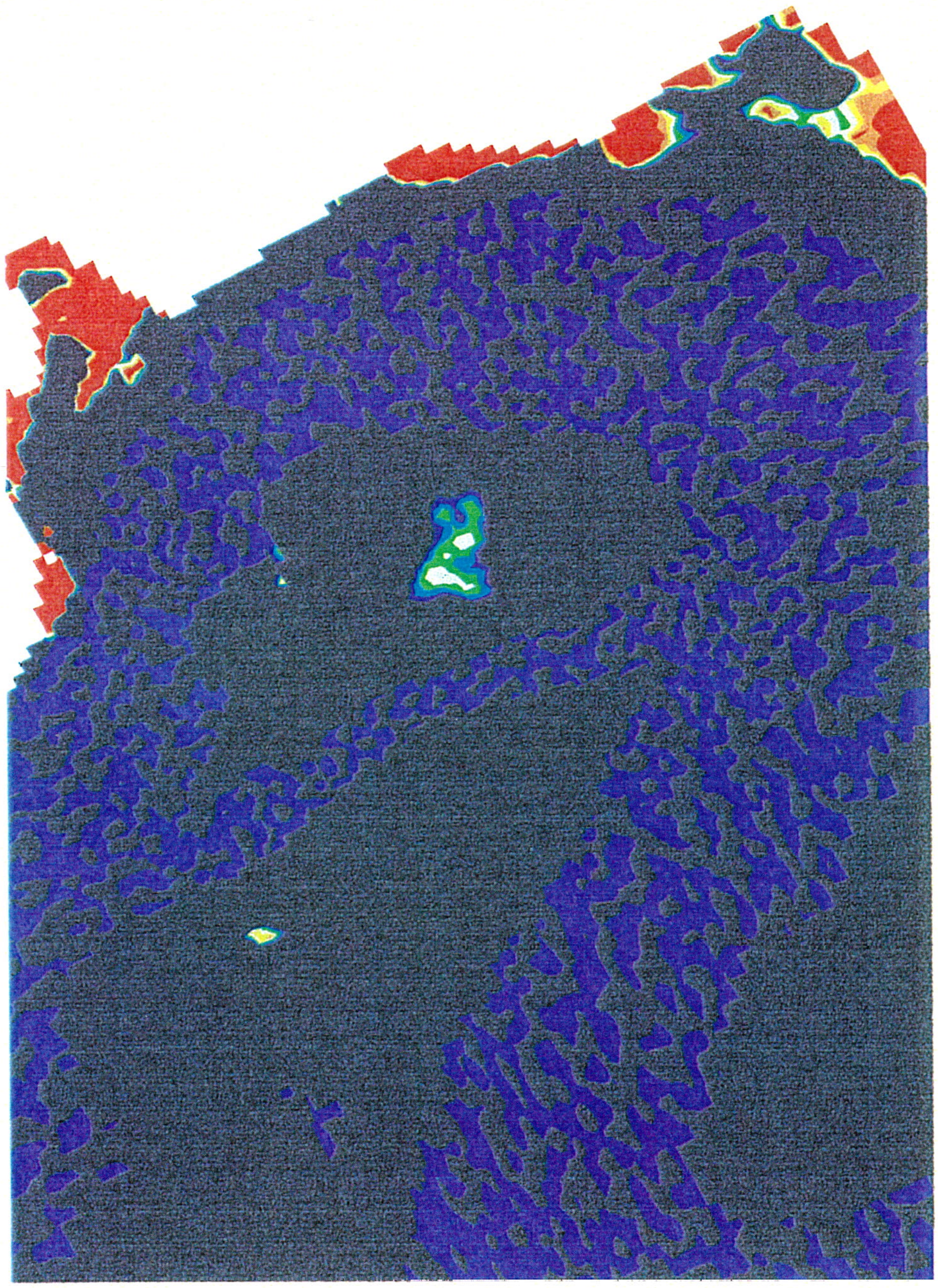
Figure 3.11



<0.000	<150.000	<300.000
<50.000	<200.000	>300.000
<100.000	<250.000	

Cumulative net sedimentation flux (g/m2 in 10 days)
initial condition restart from 20 days calculation
VSed = 5, tauRes = 0.3, tauSed = 0.1, ZRes = 4320

Figure 3.12

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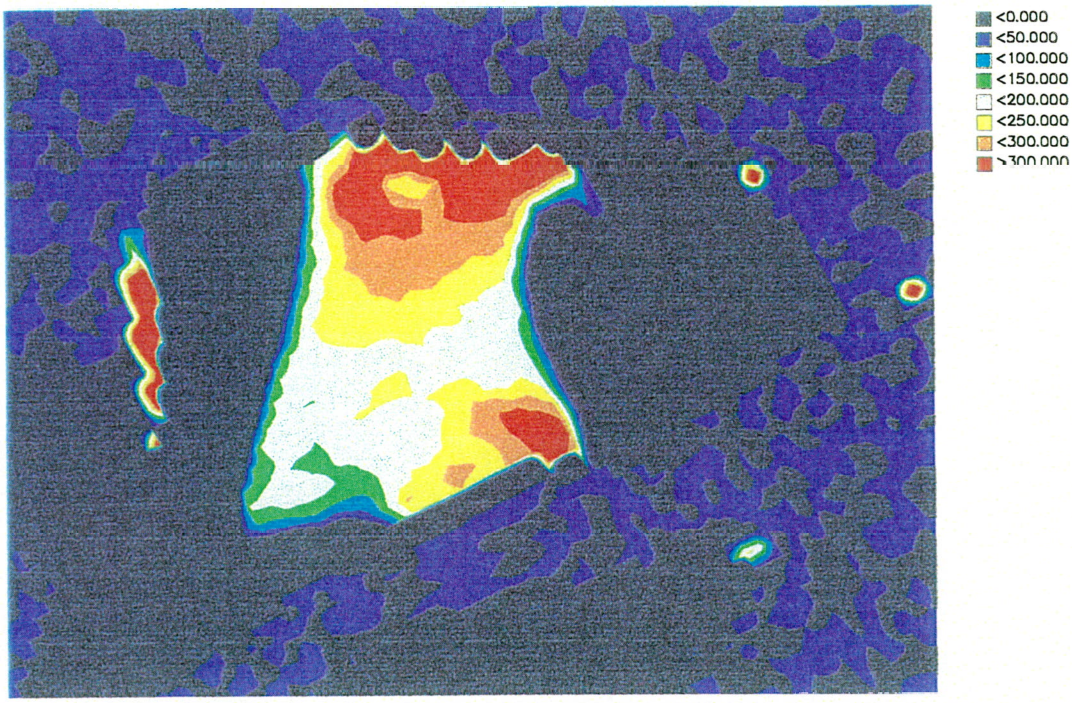

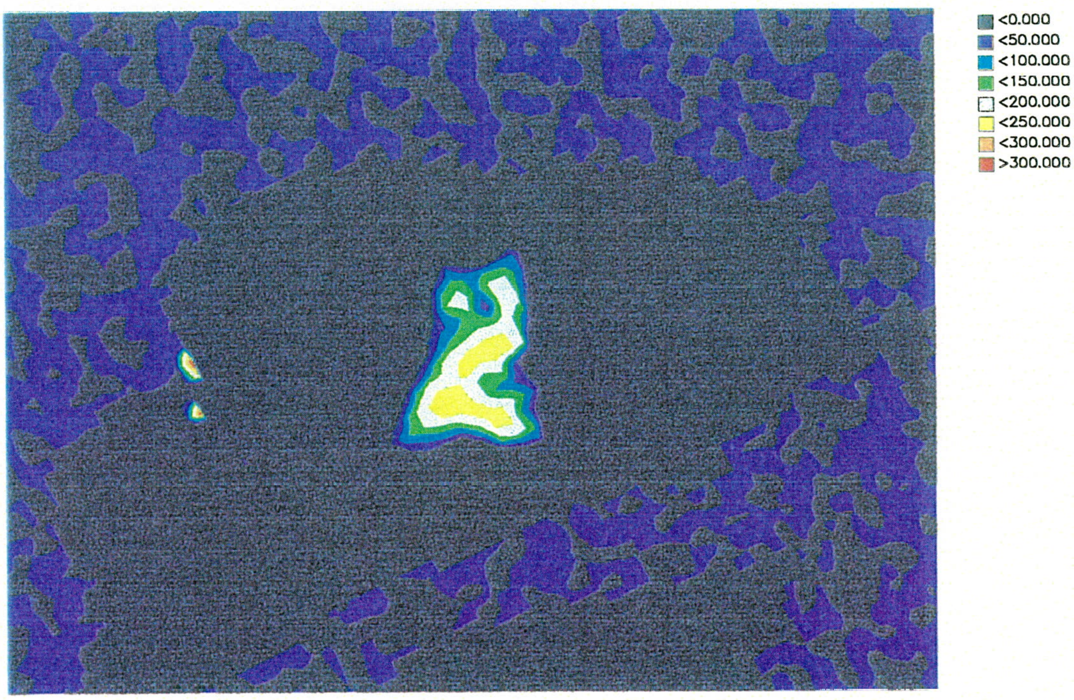

Sensitivity analysis: effect of process parameters
Upper: tRes = 0.5 instead of 0.3 Pa
Lower: VSed = 7.0 instead of 5.0 m/day

Figure 3.13

(net sedimentation flux)

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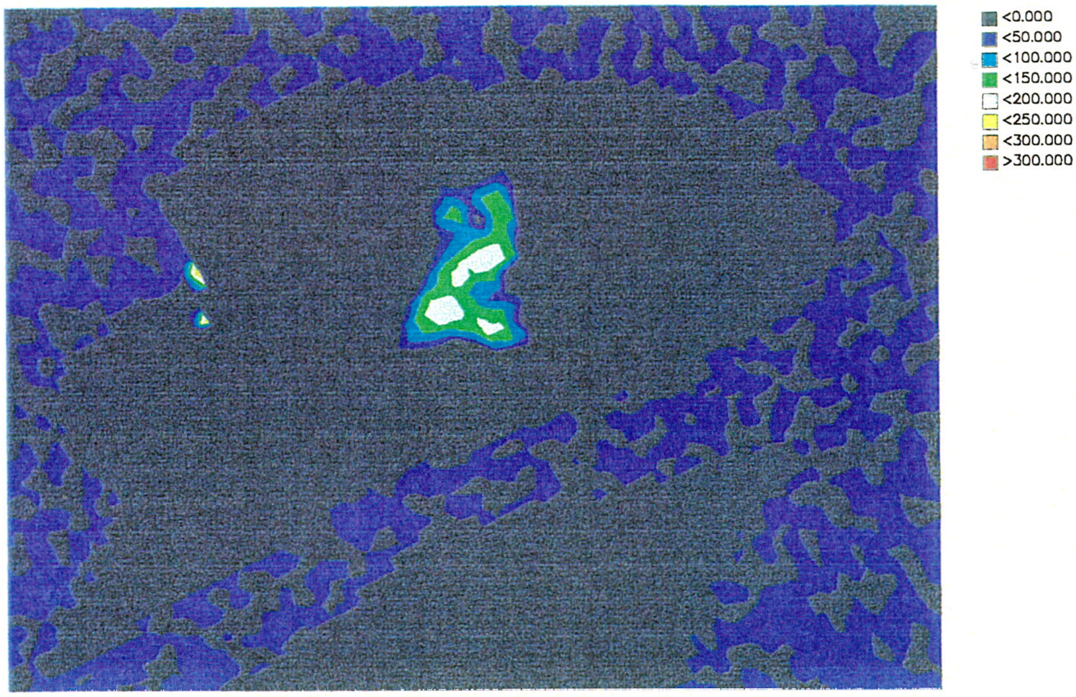

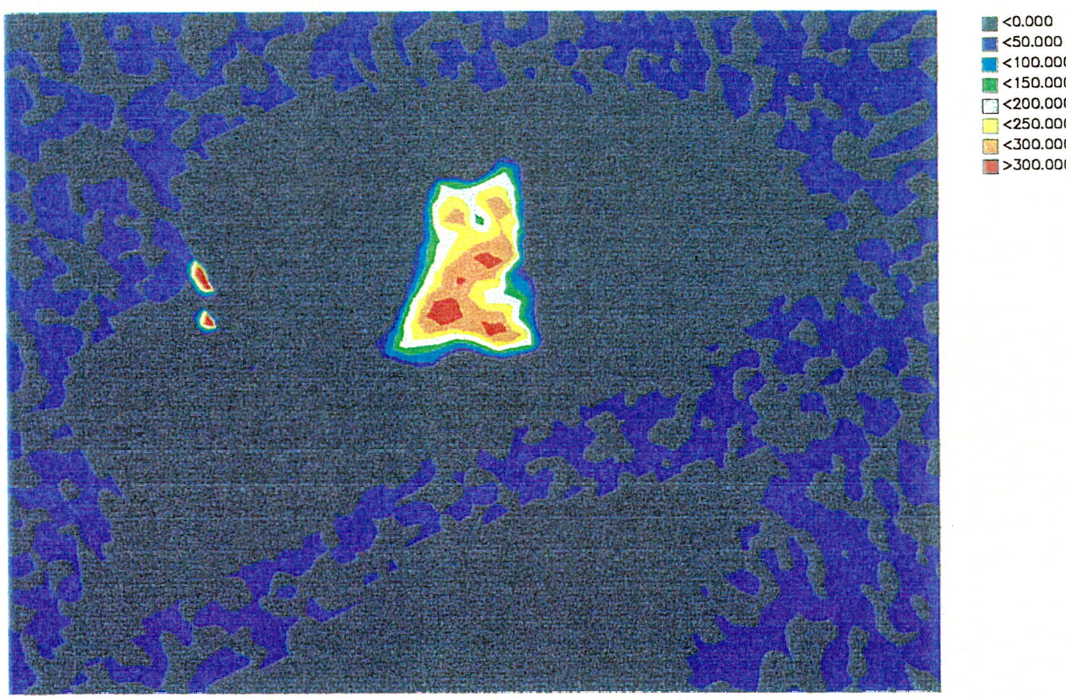

Sensitivity analysis: effect of boundaries
Upper: river boundary = 46 instead of 23 mg/l
Lower: sea boundary = 74 instead of 37 mg/l

Figure 3.14

(net sedimentation flux)

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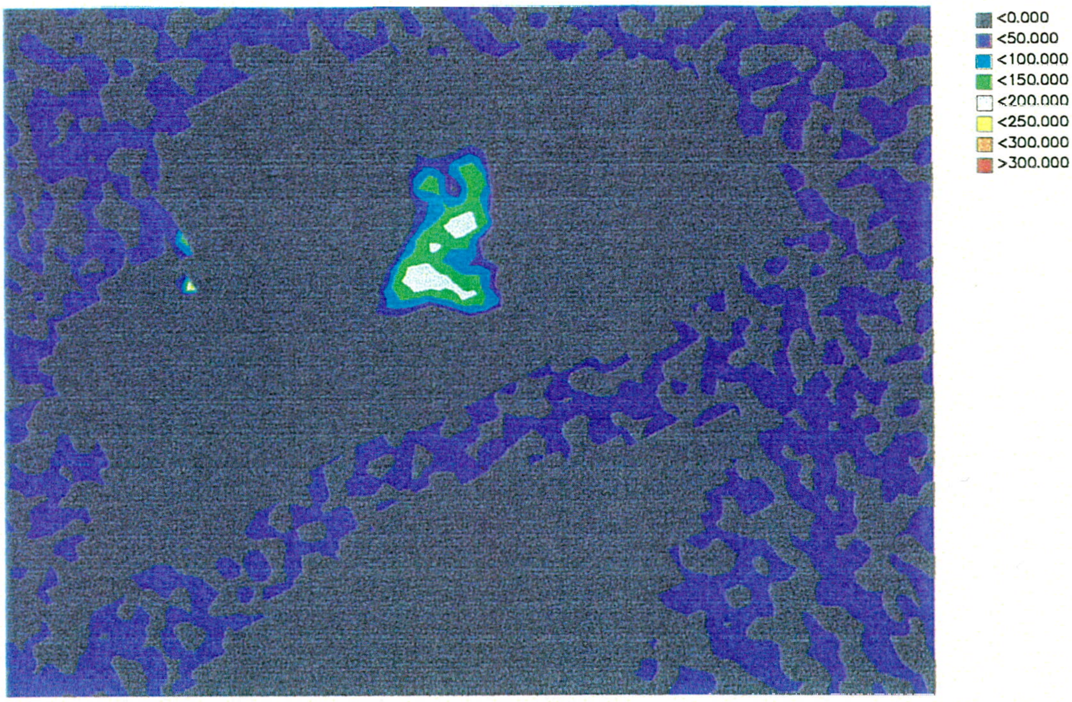

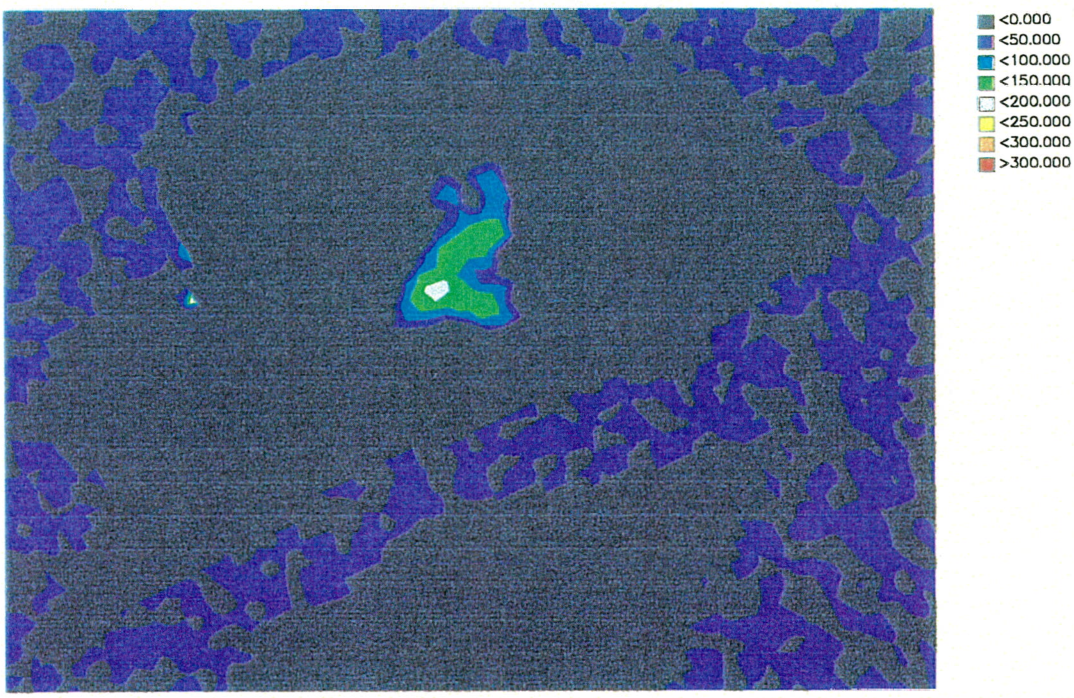

Effect of time step and calculation method
Upper: time step: 10 seconds, numerical scheme: 5
Lower: time step: 10 minuts, numerical scheme: 15

Figure 3.15

(net sedimentation flux)

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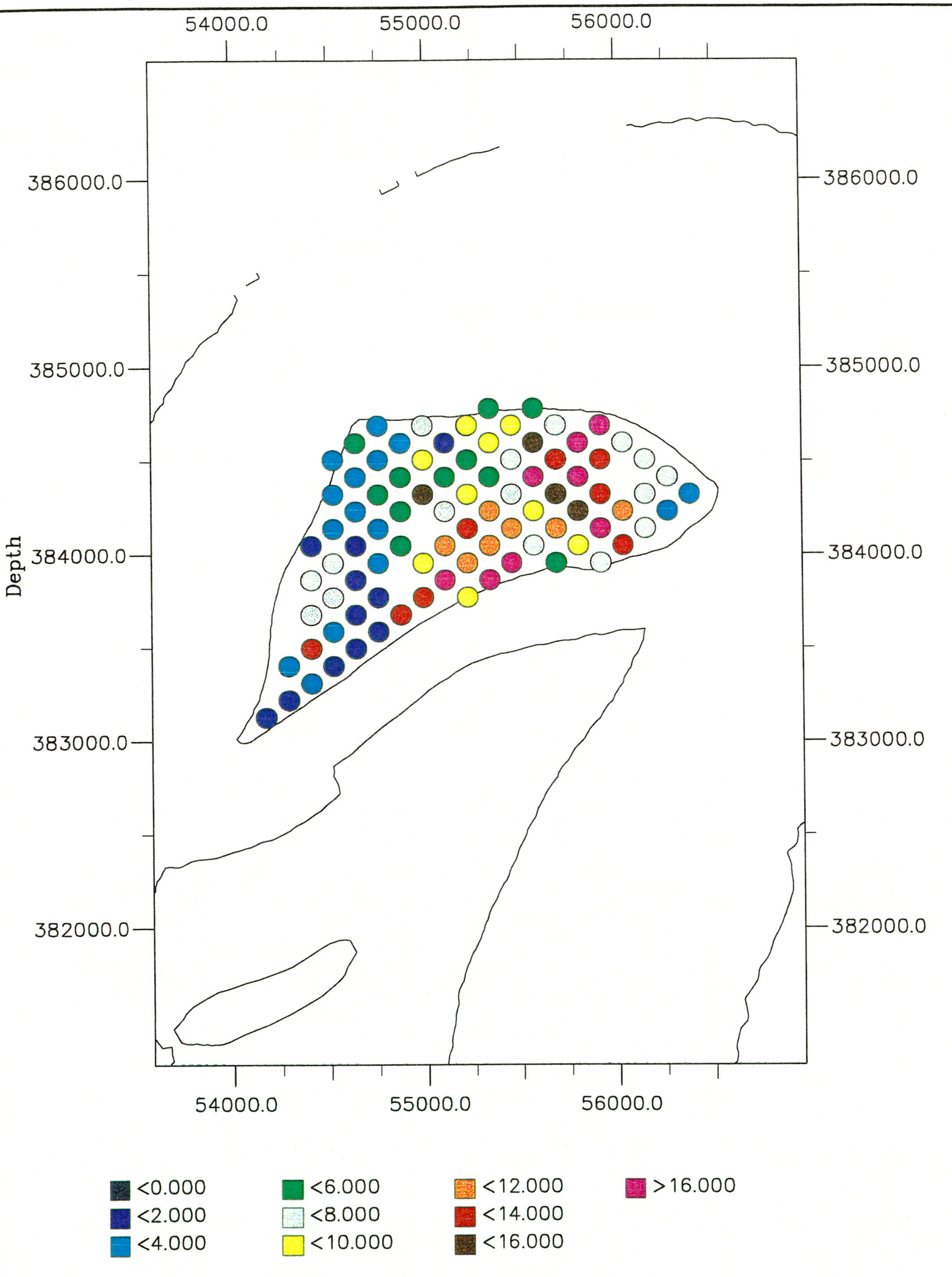

Measured percentages of chlorophyll in June 1995 in upper cm of Molenplaat sediment (mg) together with the 5 meter maximal depth isocontour		Figure 3.16
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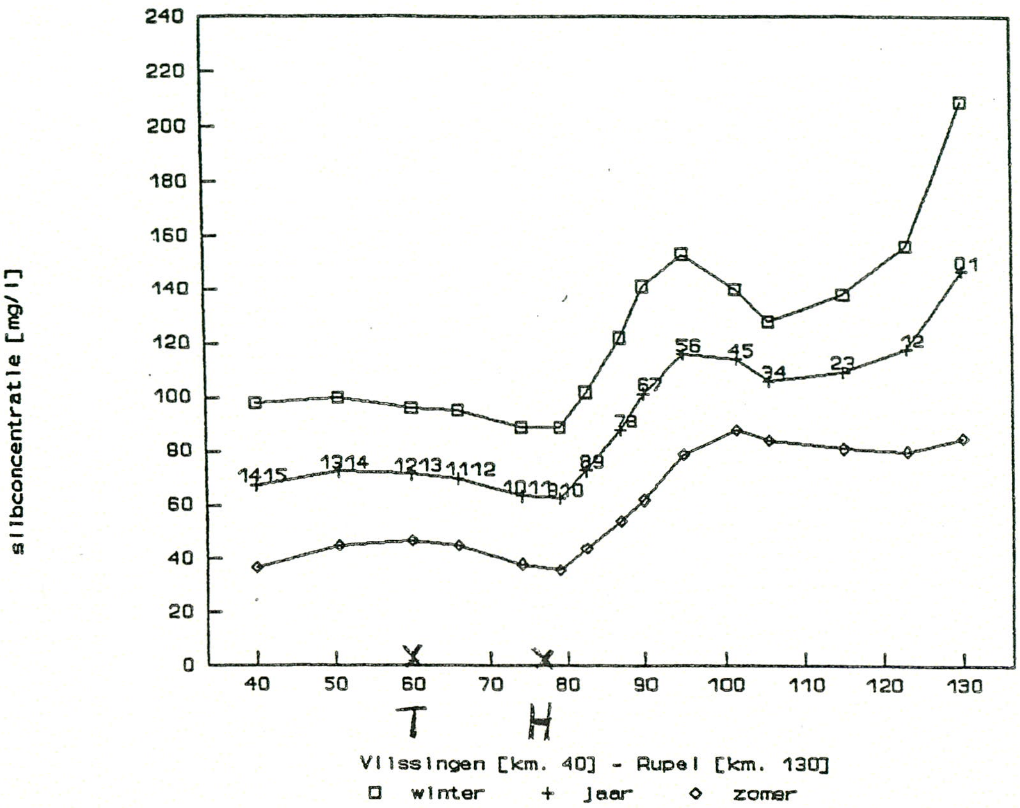

Concentrations suspended solids in the Western Scheldt (mg/l), according to van Maldegem (1992)
T = Terneuzen, H = Hansweert

Figure 3.17

B Calculation of accretion rates

B Calculation of accretion rates

Consolidated sediment under water consists partly of deposited dry matter and partly of water. In order to calculate the height of the bottom layer corresponding to 15 g dry matter that is deposited per day, the ratio between dry matter and water in wet sediment needs to be calculated.

Definitions:

M	=	mass of dry matter deposited in one day (= 15 g/m^2)	[g/m^2]
Vs	=	volume of dry matter deposited in one day	[m^3]
ρ_s	=	density of dry matter (= 2650 kg/m^3)	[kg/m^3]
ρ_w	=	density of water (= 1025 kg/m^3)	[kg/m^3]
ρ_{wet}	=	density of wet sediment (= 1325 kg/m^3)	[kg/m^3]
e	=	volume of water relative to sediment in wet sediment	[-]
h	=	height of deposited layer during one day	[m]
M_{bot}	=	mass of wet sediment	[kg]
V_{bot}	=	volume of wet sediment	[m^3]

Calculation of bottom height:

$$h = \frac{M}{\rho_s} * (1+e)$$

Calculation of 1 + e:

$$\rho_{wet} = \frac{M_{bot}}{V_{bot}}$$

=> $$\rho_{wet} = \frac{\rho_s * 1 + \rho_w * e}{1+e}$$

=> $$(1+e) * \rho_{wet} = \rho_s + \rho_w * e$$

=> $$\rho_{wet} + e * \rho_{wet} = \rho_s + \rho_w * e$$

=> $$(e * \rho_{wet}) - (\rho_w * e) = \rho_s - \rho_{wet}$$

=> $$e * (\rho_{wet} - \rho_w) = \rho_s - \rho_{wet}$$

=> $$e = \frac{\rho_s - \rho_{wet}}{(\rho_{wet} - \rho_w)}$$

=> $$1 + e = \frac{\rho_{\text{wet}} - \rho_w + \rho_s - \rho_{\text{wet}}}{(\rho_{\text{wet}} - \rho_w)}$$

=> $$1 + e = \frac{\rho_s - \rho_w}{(\rho_{\text{wet}} - \rho_w)}$$

Calculation of bottom height:

$$\text{h} = \frac{\text{M}}{\rho_s} * \frac{(\rho_s - \rho_w)}{(\rho_{\text{wet}} - \rho_w)}$$

=> $$\text{h} = \frac{15\,\text{g/ m}^2}{2650\,\text{kg/ m}^3} * \frac{(2650 - 1025)}{(1325 - 1025)} = 0.03\,\text{mm/ day} = 0.9\,\text{mm/ month}$$

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