Oesterdam T=0 measurements:

Mini sand nourishments

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Title

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Keywords

Oesterdam, sand transport sediment behavior, mini sand nourishments.

Summary

The realization of the storm surge barrier and the two secondary dams changed not only the hydrodynamics but also the geomorphological characteristics of the Oosterschelde estuary. These engineering works created a disequilibrium between erosion and sedimentation. At this moment there is a sand deficit on the Oosterschelde. Intertidal areas are eroding as a response to this new state. The erosion of the tidal flats will result in the loss of these areas with repercussions on the ecosystem level, with a loss of biodiversity and habitat but also on the safety level.

One possible solution might be the use of sand nourishments mitigating the effects of erosion and used as soft structures for coastal protection

Under the new Oesterdam project, whose goal is to ensure the safety of the region, T = 0 measurements are done in order to understand the area and also know the characteristics and ecological value of the area.

In this report attention is given to the mini sand nourishments in the T=0 measurements. This technique is an expedite and simple technique for analyzing the sediments behavior in the area.

From the analysis of the mini sand nourishments in the Oesterdam area it is possible to conclude that the transport of sediment in the area is mainly dependent on the weather conditions. In this case the WNW winds were dominant and therefore the sand moved mainly between the East and South quadrants.

The design to the Oesterdam sand nourishment expects a sand transport from SW to NE. As these mini sand nourishments showed that the sand transport is mainly due to the weather conditions and the main direction of the wind in this area is South West it is expected that the main direction of the sand transport will be from SW to North East and in accordance to the design preconized to the sand nourishment.

Version	Date	Author	Initials	Review	Initials	Approval	Initials

State

Preliminary

This is a preliminary report, intended for discussion purposes only. No part of this report may be relied upon by either principal or third parties.

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1 BACKGROUND

1.1 INTRODUCTION

The southwest area of the Netherlands is known as the Delta area and was formerly characterized by a complex network of tidal water bodies that connected the Meuse, the Rhine and the Scheldt to the North sea. After the 1953 flood that occurred in this area the Delta project was created.

The aim of this plan was to reduce the length of the dykes directly exposed to the sea in order to improve the safety in the region. Besides the Westerschelde, all the main estuaries were closed or partly closed from the river inputs and the North Sea.

The Oosterschelde (Eastern Scheldt) is an estuary in Zeeland, Netherlands, between Schouwen-Duiveland and Tholen on the north and Noord-Beveland and Zuid-Beveland on the south. Between 1979 and 1986 a storm-surge barrier was constructed allowing the tides to enter freely, in order to try keeping the unique habitat and the shellfish culture in the Oosterschelde (Nienhuis and Smaal 1994). At the same time two compartment dams were constructed in the back area of the Oosterschelde, the Oesterdam and the Philipsdam

Two dams on the east side of the Oosterschelde were built to reduce its surface area enhancing the tidal movements and, at the same time, its construction made sure that the Scheldt-Rhine canal was no longer influenced by the tides.

Although the new design was less drastic for the estuarine environment of the Oosterschelde, it still induced many morphological and ecological changes that are still going on at present. The total surface area of the Oosterschelde is now 351 km^2, of which 114 km^2 are tidal flats and 6,41 km^2 are salt marshes. The water flow has also decreased and the tidal range has reduced from 3.40 meters to 3.25 meters. This has an effect on the total area under tidal influence which has reduced by 22%, and the water exchange with the North Sea has decreased by 28%, which has consequently decreased the current velocities and turbidity. Due to this reduction a new geomorphological equilibrium between erosion and sedimentation has evolved (Smaal and Nienhuis, 1992).

In the case of the Oosterschelde there is a sand deficit and the gullies are slowly filling up with sediments from the tidal flats, causing erosion of tidal flats and a reduction of emersion time (the so-called 'sand hunger' of the Oosterschelde; Van Zanten and Adriaanse 2008). Therefore, the habitat for intertidal soft-bottom benthic fauna is slowly disappearing, and with it food sources for estuarine birds that use these areas as foraging grounds (Mulder and Louters. 1994). Erosion of tidal flats also locally exposes deeper peat layers, potentially resulting in a reduced water clarity and primary production (Nienhuis and Smaal 1994a; Geurts van Kessel et al. 2003 in Troost 2009).

The slow disappearance of tidal flats and salt marshes will also result in an increased risk of dike ruptures and flooding during storm surges, because the dikes become more exposed to wave action (Van Zanten and Adriaanse 2008).

Nowadays, in order to ensure the safety of the region, taking also into consideration the sea level rise, it is necessary to reinforce the Oesterdam. For the new project, to the traditional asphalt dike(Oesterdam Dike) a ‘soft structure’ is going to be added.

The Oesterdam dike is designed to reach the intended safety standard of the region. The soft structure, placed in front of the dike, is going to provide extra safety, and presumably also a reduction of the maintenance of the dike and an increase in the life time of the project.

The Ecological design of the nourishment and stabilization of the sediment were prioritized in order to achieve an optimization of the services.

In the framework of the Oesterdam reconstruction project and in order to achieve the best ecological value for the area it is necessary to know the actual conditions and ecology of the area. Therefore before the construction measurements are being done.

The measurements are designated T= 0 measurements and are going to be used as comparison to future measurements that will occur not only during the construction phase but also later on.

In this report attention is given to the mini sand nourishments during T=0 measurements. This technique is an expedite and simple technique for analyzing the sediments behavior in the area.

1.2 AIM

The realization of the storm surge barrier and the two secondary dams changed not only the hydrodynamics but also the geomorphological characteristics of the Oosterschelde estuary. These engineering works created a disequilibrium between erosion and sedimentation. At this moment there is a sand deficit on the Oosterschelde. Intertidal areas are eroding as a response to this new state. The erosion of the tidal flats will result in the loss of these areas with repercussions on the ecosystem level, with a loss of biodiversity and habitat but also on the safety level.

By developing cost efficient and sustainable structures for coastal protection not only the Oosterschelde will benefit, but also areas with the same conditions and problems around the world. One possible solution for this problem might be the use of sand nourishments mitigating the effects of erosion and used as soft structures for coastal protection.

Under the new Oesterdam project, whose goal is to ensure the safety of the region, T = 0 measurements are done in order to understand the area and also know the characteristics and ecological value of the area.

In this report attention is given to the mini sand nourishments in the T=0 measurements. This technique is an expedite and simple technique for analyzing the sediments behavior in the area.

2 MINI SAND NOURISHMENTS

The mini sand nourishments will complement the information gathered by other methodologies during the T=0 measurements and will give an overview on the behaviour of the sediment transports and sedimentation patterns in the tidal flat next to the Oesterdam for a given period of time and weather conditions.

2.1 MINI SAND NOURISHMENTS METHOD

This technique is an easy way to assess the behaviour of the sediment transports and sedimentation on tidal flats.

The principle behind this technique is to create, with sand, a circular shape with 1,0m radius and a volume of approximately 0,50 m^3 which means the use of four "mudcar" with sand. This circular shape should be as homogenous as possible.

The Setup method for implementing the Mini Sand Nourishments is the following:

i) Placement of a Bamboo stick on the place where is going to be performed the mini sand nourishment;

ii) Provision of enough sand, with the "mudcar", to create the necessary volume (approximately 0,50 m^3);

iii) Creation of a volume with 1,0m of radius centred in the bamboo stick, special attention is needed to the homogeneity of the volume.

iv) Measure the length of the bamboo stick outside the sand nourishment.

After a minimum period of at least 48h it is possible to proceed to measurements.

The setup for the measurements is the following:

i) Draw a circle with 1,0m of radius and centre on the bamboo stick:

ii) Draw the new shape made by the previously deposited sediment.

iii) Mark with the help of a compass the North and seven other cardinal points(South, East, West, North-East, North-West, South-East and South-West)

iv) Register in Each direction the length of the sediment

v) Register the direction and location of the highest sediment point;

vi) Measure the length of the bamboo stick outside the sand nourishment.

This technique gives an expedite way of measuring not only the main direction of the hydrodynamics forces but also the main direction of the sediment transports in the place followed by the rate of erosion for a given period of time and weather conditions.

For the study in question this method will be applied around the tidal flat. Figure 1 exemplifies the position of the mini sand nourishments around the tidal flat for a clear comparison.

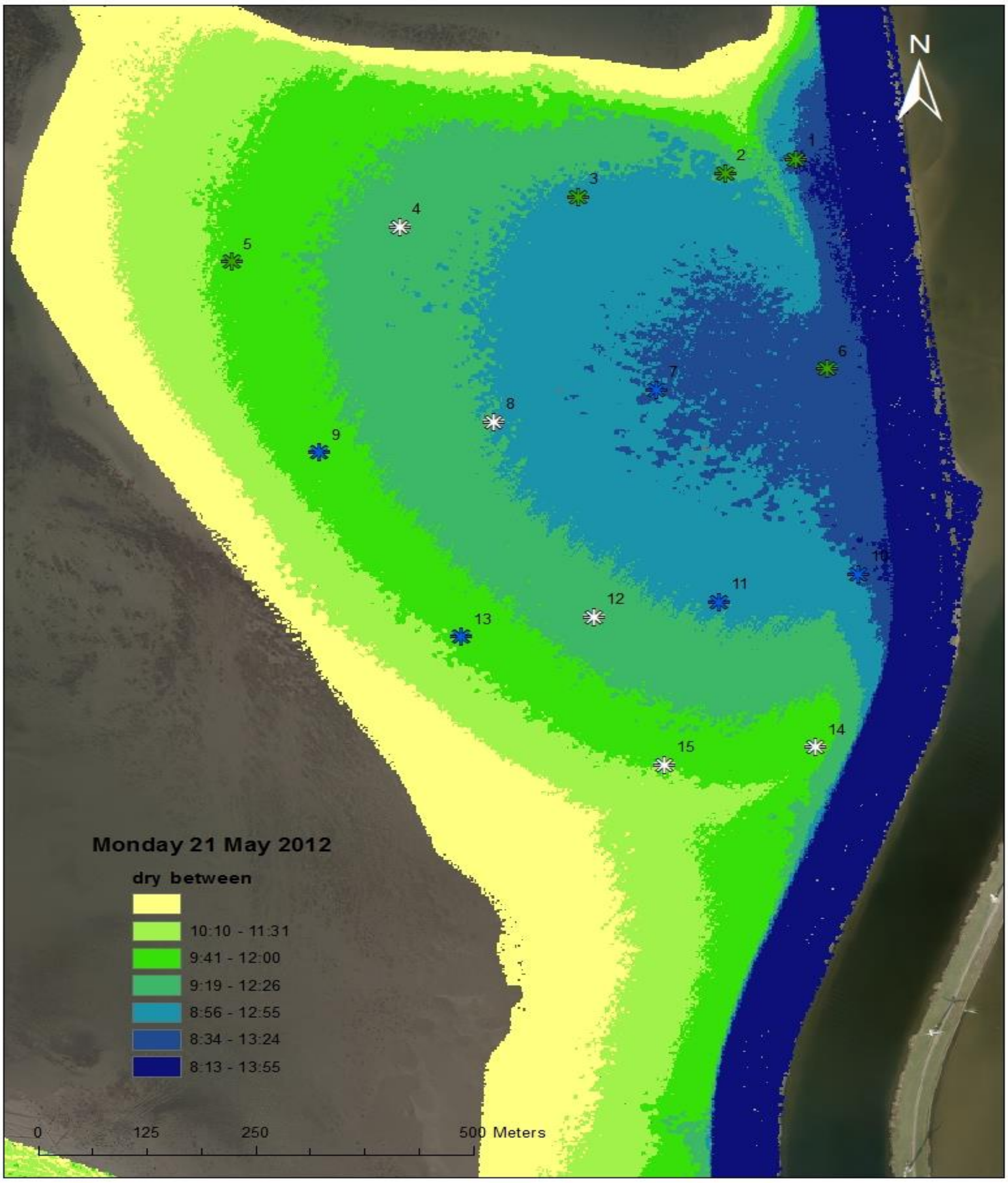

Figure 1 Scheme of the mini sand nourishments positioned on the tidal flat.

Figure 2 represents a mini sand nourishment after being built and 48h later during the measuring period.

Figure 2 Mini sand nourishment after building (T0, left photo) and after a 48h period (right photo). The inner circle denotes the original position of the mini sand nourishment, the outer circle the position of the sediment after 48h.

3 RESULTS AND DISCUSSION

In order to assess the behaviour of the sediment transport and sedimentation in the tidal flat 15 mini sand nourishments were built on it as it was shown in Figure 1.

Usually the results of the mini sand nourishments are directly related to the weather conditions (i.e. wind) and hydrodynamics of the area during the measuring period. Table 1 represents the average weather conditions for the measuring period. The complete weather conditions for the mini sand nourishments in question are presented in the Appendix 2.

Table 1 Average weather conditions of the Oesterdam area

Wind speed (m/s)	Wind direction (degree)	Significant wave height (cm)
5,56	289,76	24,83

From the table we can conclude that the average wind speed is 5,56 m/s and the main direction was approximately WNW and that the significant wave height was approximately 0,25 m.

Table 2 presents the results of the measurements of sand nourishments in the Oesterdam tidal flat. Table 1 from appendix 1 is the complete table with the measurements from the sand nourishments of the tidal flat.

Table 2 Measured Parameters on the mini Sand nourishments

Name	Sub Area	Main Direction of the sediment transport	Highest point	Movement [cm/day]	Diference per day in the center [cm/Day]
1	North	SE	SE	43	6,93
2	North	ESE	ESE	27	2,90
3	North	S	SSE	30	3,00
4	North	SE	SE	27	4,07
5	North	SE	SE	39	4,00
6	Center	E	ESE	25	3,00
7	Center				
8	Center	E	E	33	5,00
9	Center	E	ESE	40	5,33
10	Center	E	E	15	
11	Center	E	E	17	-0,40
12	Center	ENE	ENE	32	6,90
13	South	E	E	42	4,67
14	South	SW	SW	8	
15	South	ENE	ENE	17	1,33

From the fifteen sand nourishments the main direction of the sediment transport is between East and South. The same conclusion is possible to take for the Highest point. The only exceptions are the 12th, 14th and the 15th sand nourishments.

Due to the disappearance of the bamboo stick in the centre of the 7th mini sand nourishment it was impossible to get results for this sand nourishment.

From a comparison between the two previous tables(Table 1 and Table 2) it is possible to conclude that the results of the mini sand nourishments are mainly related to the weather conditions of the area during the measuring period. Some of the results can't be explained only by the weather conditions and therefore these sand nourishments were also under influence of hydrodynamic forces able to transport sediment.

When analysing in more detail it is possible to conclude that the most dynamic areas are the located more close to the gullies in the north and also in the west (mini sand nourishments 1,5, 9 and 13) as these sand nourishments show a higher movement and a higher difference per day. These can be explained by an higher exposure of the mini sand nourishments to waves in these areas.

The least dynamic area is located near the 14th mini sand nourishment as it was registered the smallest movement of sand. This is according to what was expected as this area presented also the highest quantity of finer sediments(mud).

In appendix 1 a graphic representation of the results for each mini sand nourishment is presented. The chart presents the lengths for several directions in the beginning and end of the measurement period. In these charts the most dynamic place is considered the place where the difference between the final measurement and the initial measurement (T0) is higher in absolute values.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

From the analysis of the mini sand nourishments in the Oesterdam area it is possible to conclude that the transport of sediment in the area is mainly dependent on the weather conditions. In this case the WNW winds were dominant and therefore the sand moved mainly between the East and South quadrants.

From a comparison between all the sand nourishments it is highlighted that the most dynamic areas are the ones more close to the north and west gullies. One reason is the higher influence of the waves in these areas.

The least dynamic area is located near the 14th mini sand nourishment. This fact was concluded not only because of the smallest movement of sand registered but also due to the presence of finer sediments in the area which is related to lower hydrodynamic conditions.

The design to the Oesterdam sand nourishment expects a sand transport from SW to NE. As these mini sand nourishments showed that the sand transport is mainly due to the weather conditions and the main direction of the wind in this area is South West it is expected that the main direction of the sand transport will be from SW to North East and in accordance to the design preconized to the sand nourishment.

4.2 RECOMMENDATIONS

As stated before the effects on the erosion/sedimentation patterns are not only related to the weather conditions. The hydrodynamics of the system also have great influence on the observed patterns, along with punctual events like storms. The previous fact support the necessity of studying other parameters to have a global idea on how the sand nourishment will behave. Also more mini sand nourishments for different weather conditions are necessary in order to understand better the sediment transport of the area and prove that indeed it is mainly related to the weather conditions.

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APPENDIX 1 – MINI SAND NOURISHMENTS

Appendix 1 – Mini Sand Nourishments

This appendix contains the individual charts for every mini sand nourishment and also one table with all the measured parameters on the mini sand nourishments.

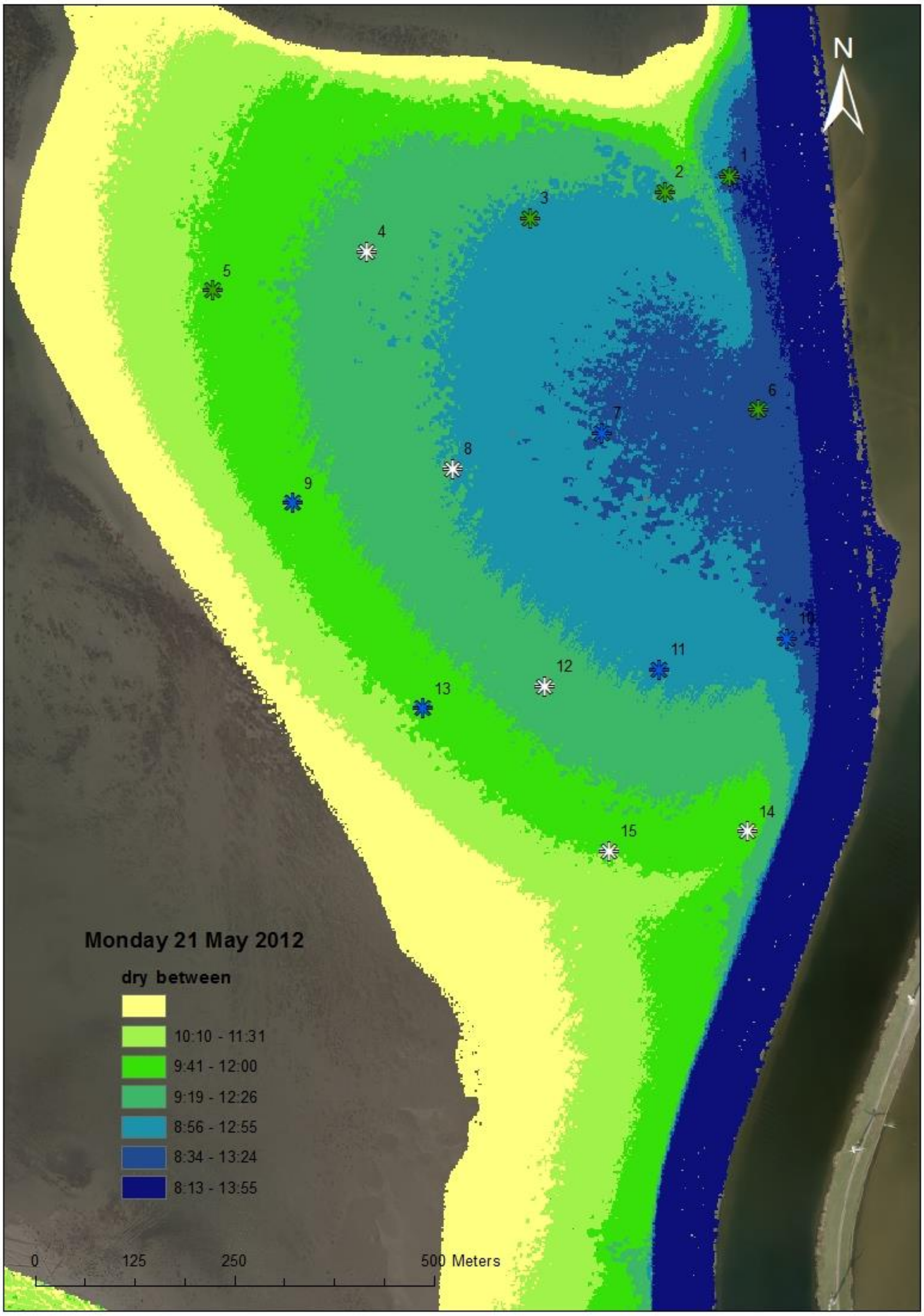

Figure 3 Location of the mini sand nourishments in the tidal flat close to the Oesterdam

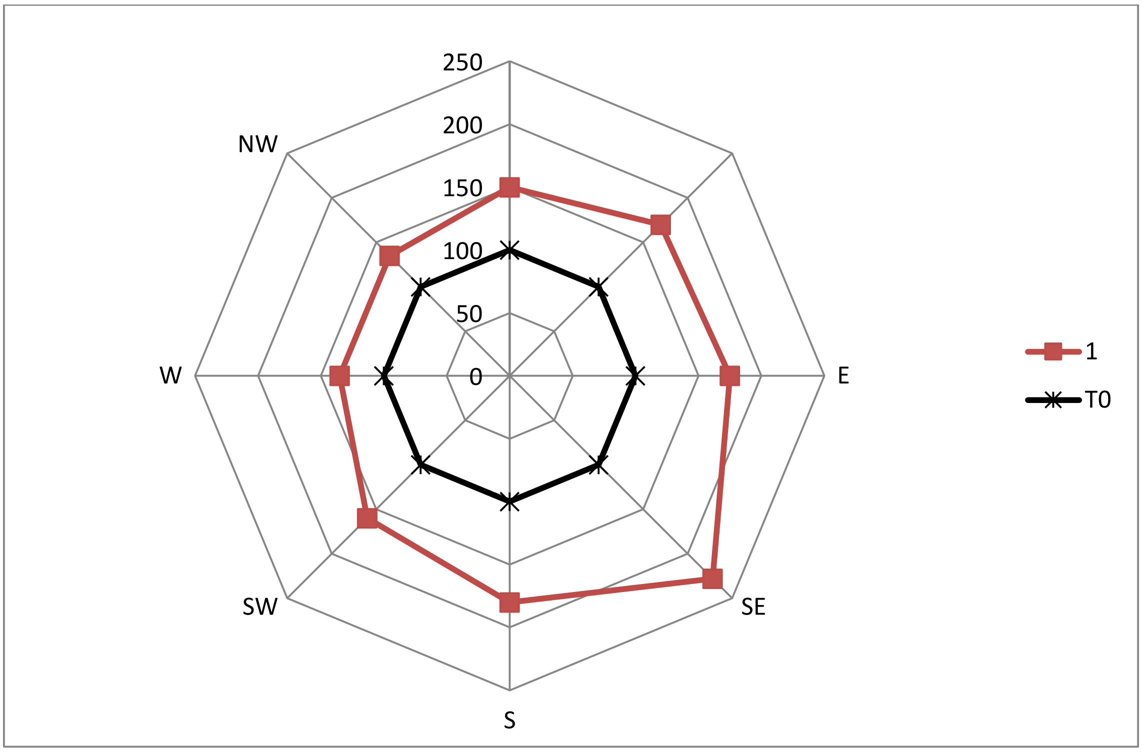

Chart 1 Oesterdam mini sand nourishment number 1

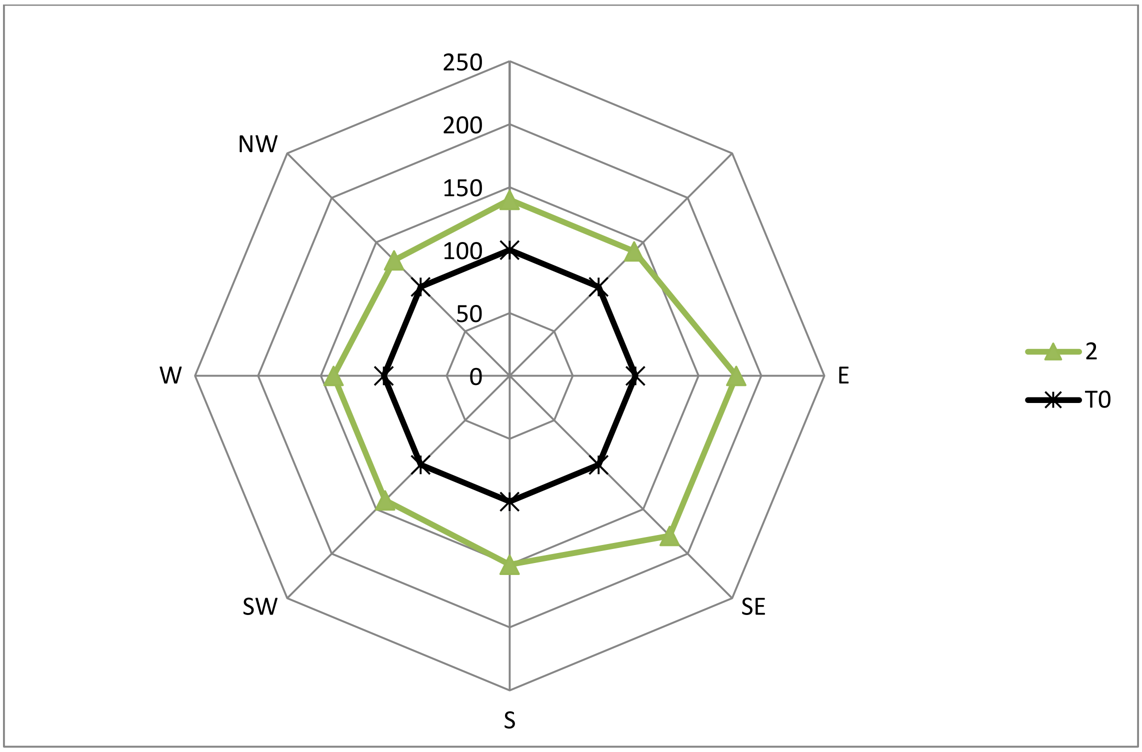

Chart 2 Oesterdam mini sand nourishment number 2

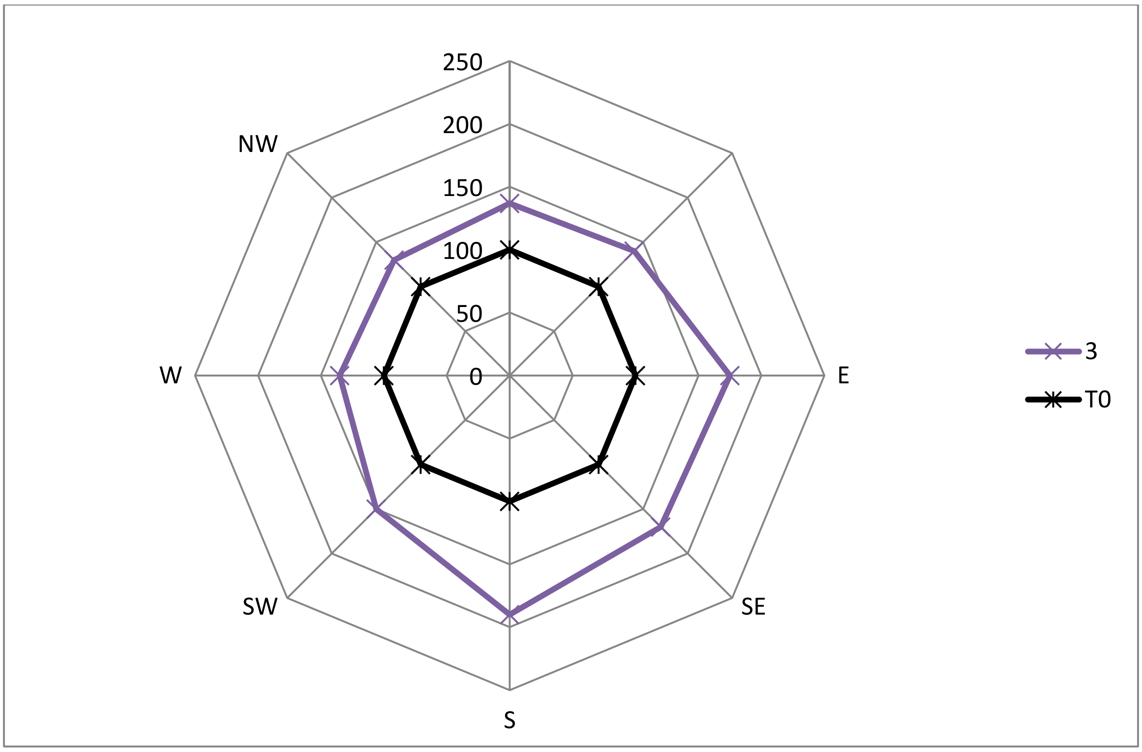

Chart 3 Oesterdam mini sand nourishment number 3

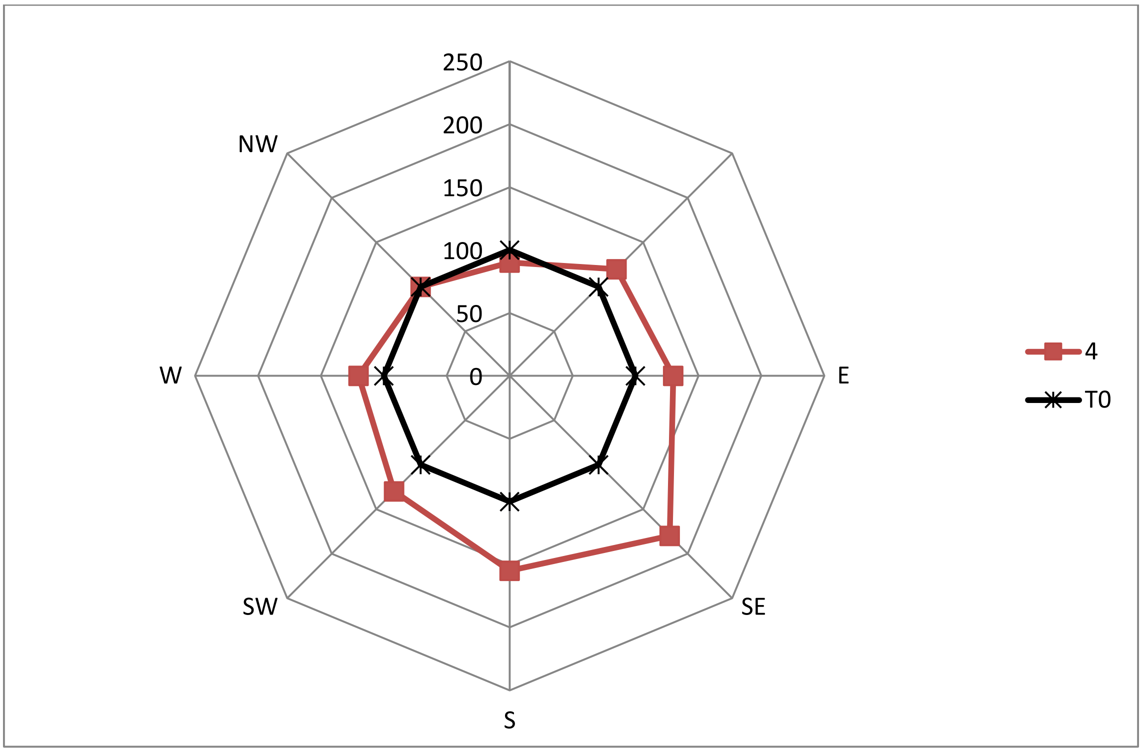

Chart 4 Oesterdam mini sand nourishment number 4

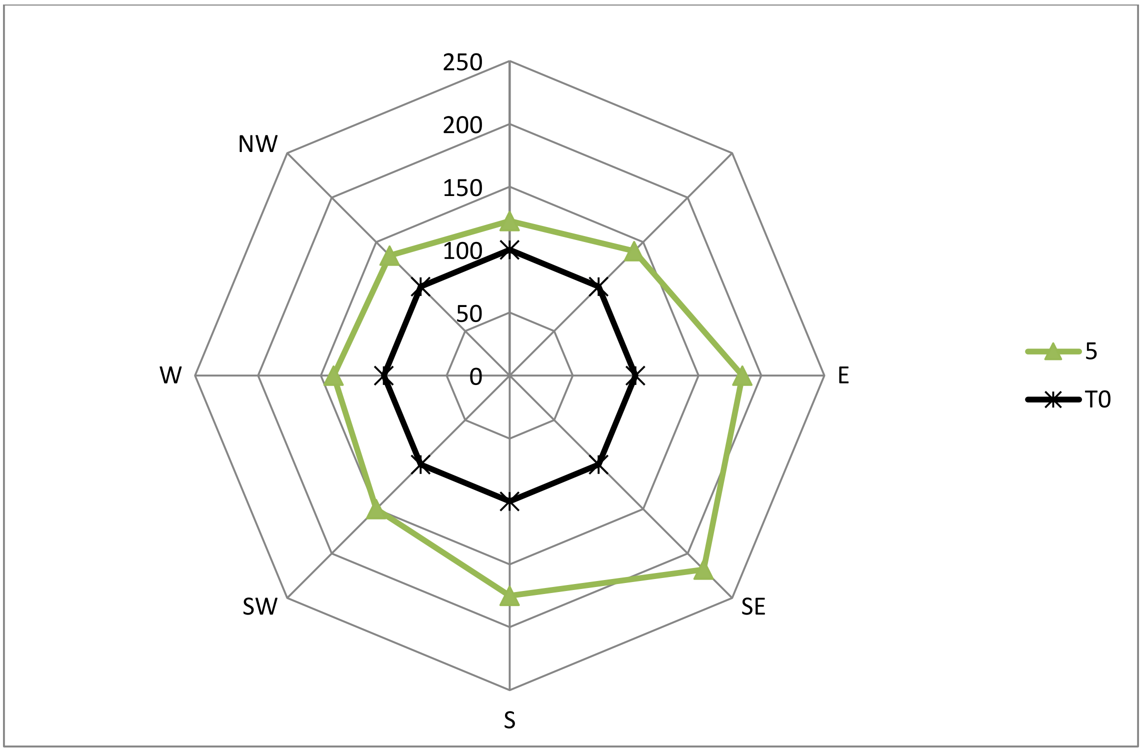

Chart 5 Oesterdam mini sand nourishment number 5

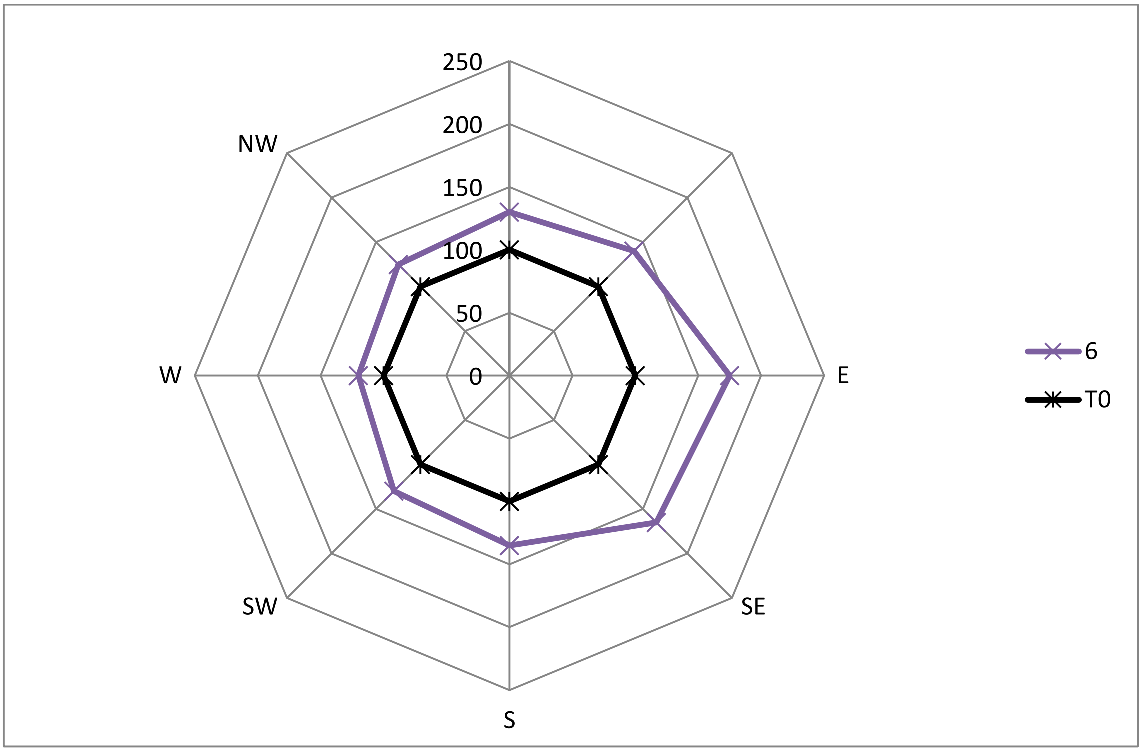

Chart 6 Oesterdam mini sand nourishment number 6

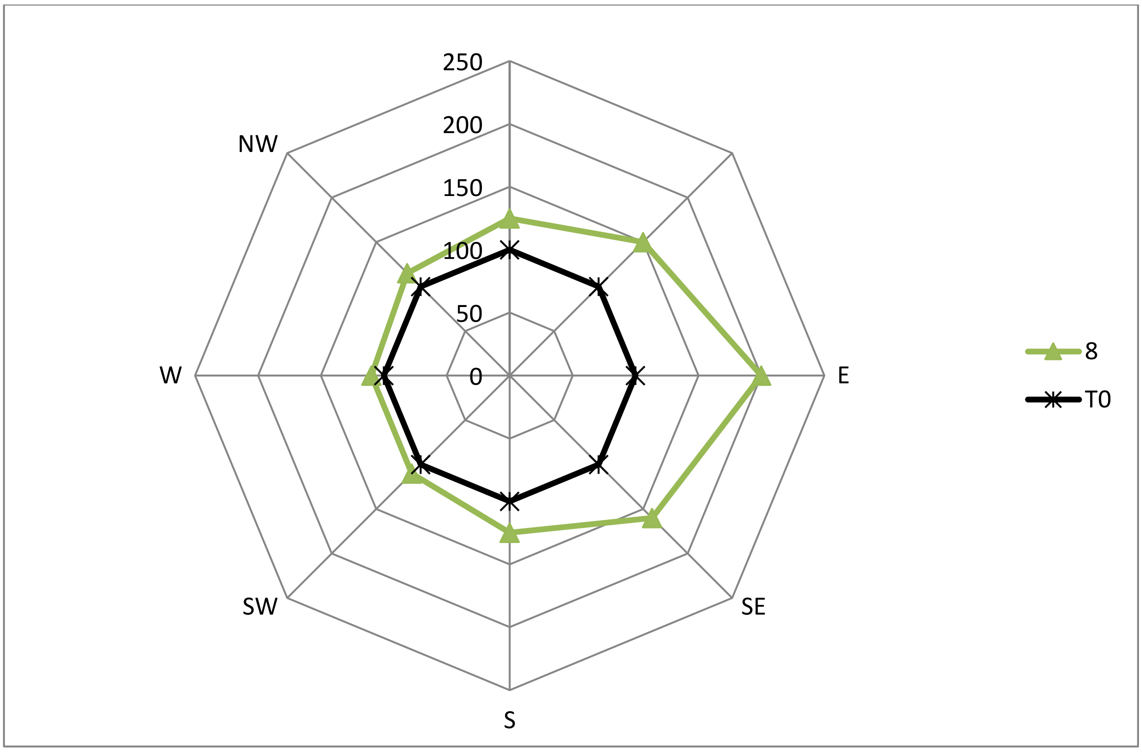

Chart 7 Oesterdam mini sand nourishment number 8

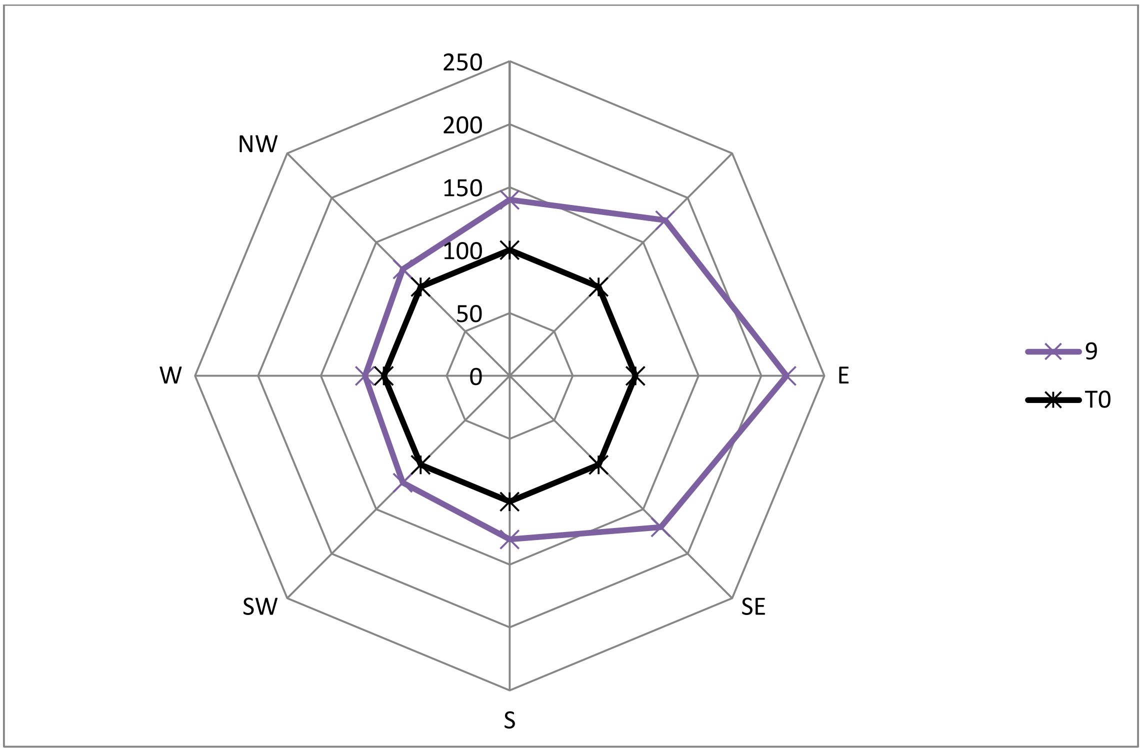

Chart 8 Oesterdam mini sand nourishment number 9

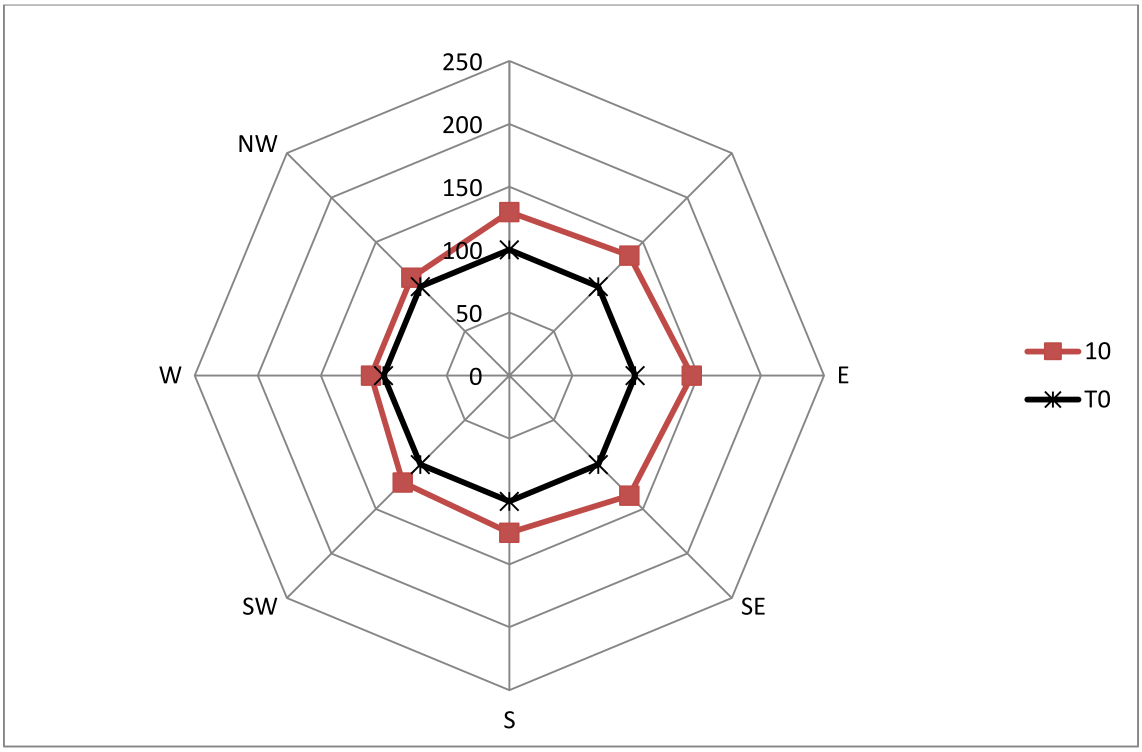

Chart 9 Oesterdam mini sand nourishment number 10

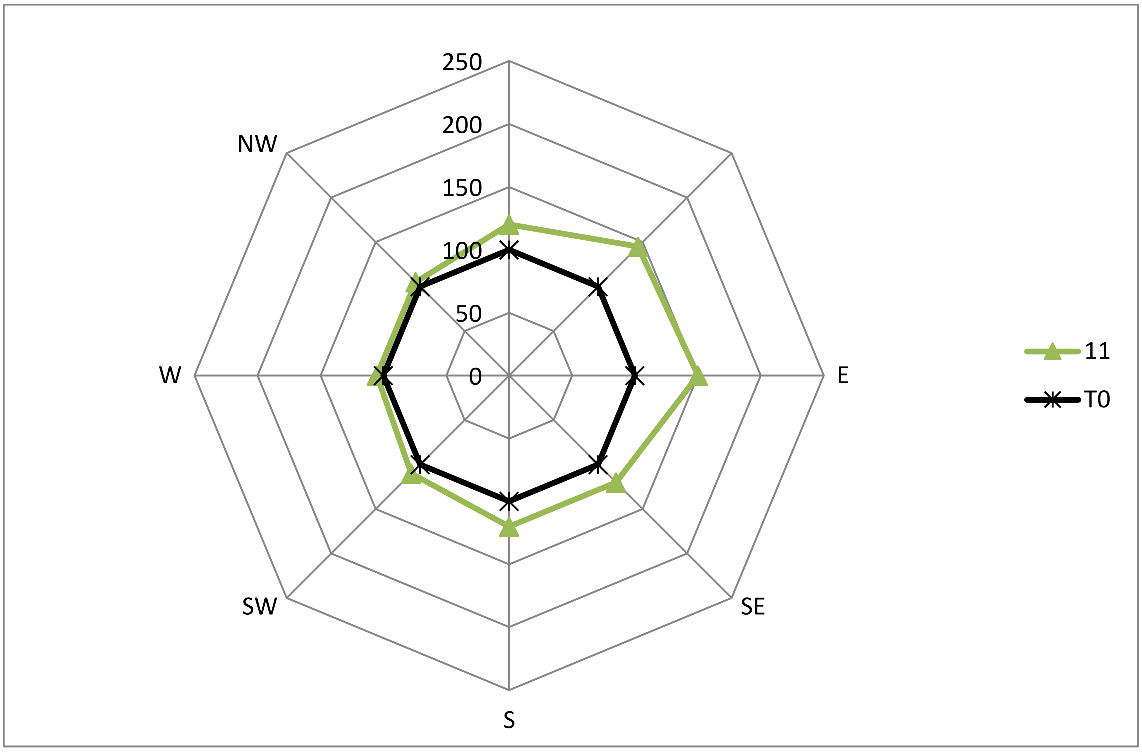

Chart 10 Oesterdam mini sand nourishment number 11

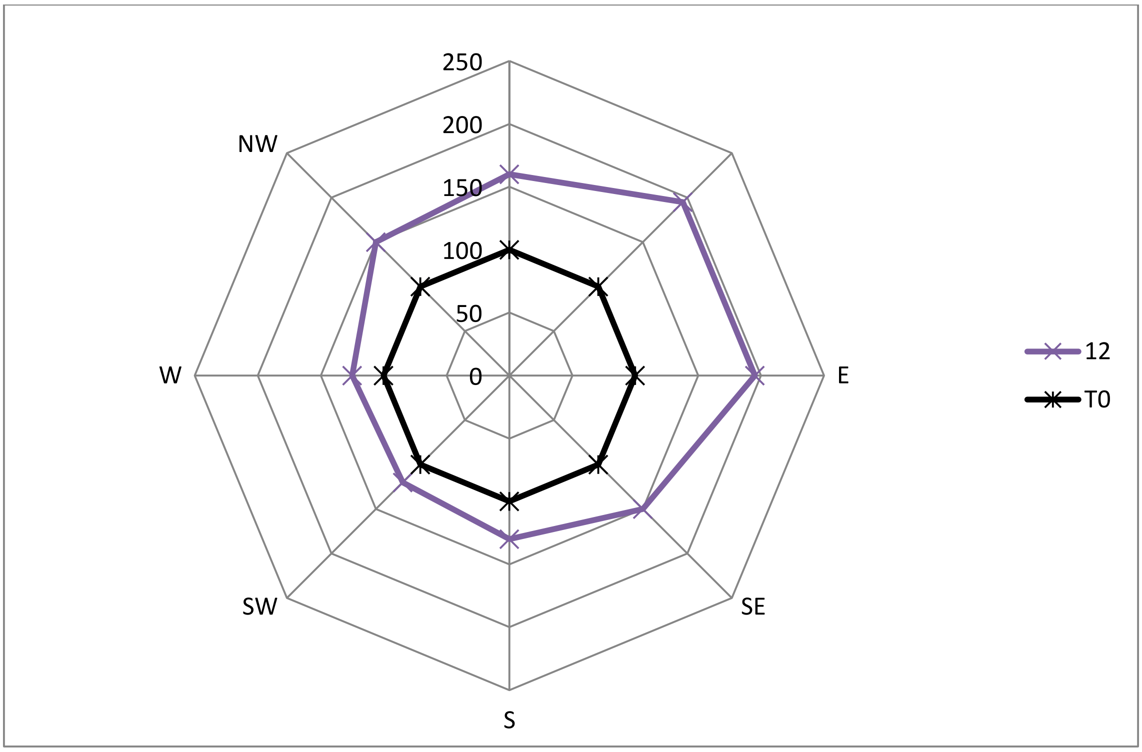

Chart 11 Oesterdam mini sand nourishment number 12

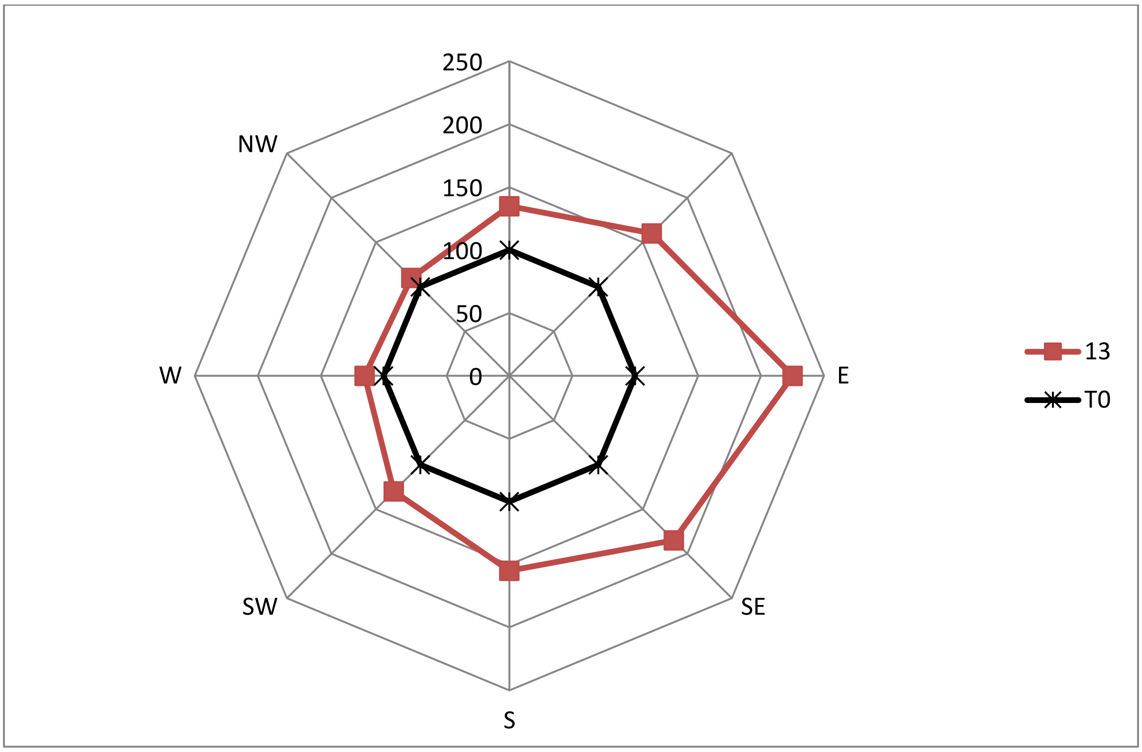

Chart 12 Oesterdam mini sand nourishment number 13

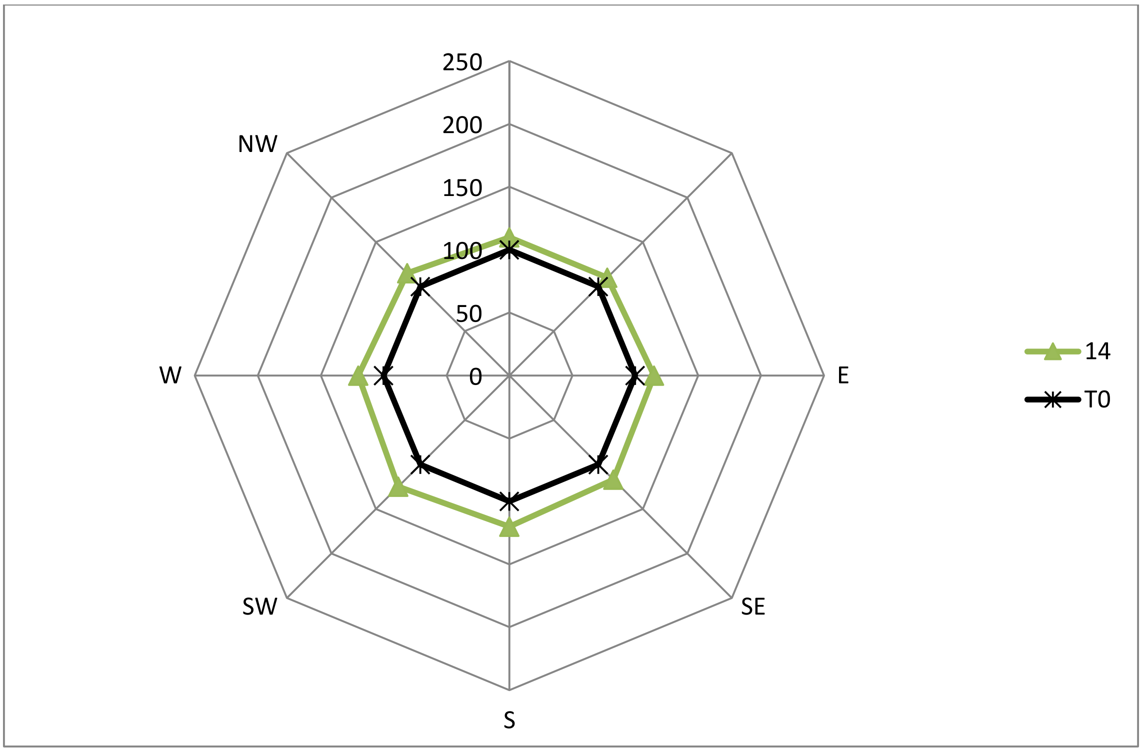

Chart 13 Oesterdam mini sand nourishment number 14

Chart 14 Oesterdam mini sand nourishment number 15

Table 3 Measured Parameters on the mini Sand nourishment at the Oesterdam

Name	Placing	Measuring	Area	Sub Area	X-center	Y-center	N	NE	E	SE	S	SW	W	NW	Direction	Highest point	Number of days between measurements	Movement [cm/day]	Inicial height in the center [cm]	Final height in the center [cm]	Diference [cm]	Diference per day in the center [cm/Day]
1	21-5-2011	24-5-2011	Oesterdam	North	73.936.928	387.310.630	150	170	175	228	180	160	135	135	SE	SE	3	43	69,20	90,00	20,80	6,93
2	21-5-2011	24-5-2011	Oesterdam	North	73.855.273	387.291.033	140	140	180	180	150	140	140	130	ESE	ESE	3	27	56,30	65,00	8,70	2,90
3	21-5-2011	24-5-2011	Oesterdam	North	73.685.430	387.258.371	137	140	175	170	190	150	135	130	S	SSE	3	30	67,00	76,00	9,00	3,00
4	21-5-2011	24-5-2011	Oesterdam	North	73.480.794	387.215.940	90	120	130	180	155	130	120	100	SE	SE	3	27	62,80	75,00	12,20	4,07
5	21-5-2011	24-5-2011	Oesterdam	North	73.285.658	387.167.156	123	140	185	218	175	150	140	135	SE	SE	3	39	68,00	80,00	12,00	4,00
6	21-5-2011	24-5-2011	Oesterdam	Center	73.972.857	387.016.672	130	140	175	165	135	130	120	125	E	ESE	3	25	71,00	80,00	9,00	3,00
7	21-5-2011	24-5-2011	Oesterdam	Center	73.776.884	386.987.276											3		69,00		-69,00	
8	21-5-2011	24-5-2011	Oesterdam	Center	73.588.968	386.942.325	125	150	200	160	125	110	110	115	E	E	3	33	68,00	83,00	15,00	5,00
9	21-5-2011	24-5-2011	Oesterdam	Center	73.387.468	386.899.905	140	175	220	170	130	120	115	120	E	ESE	3	40	71,00	87,00	16,00	5,33
10	21-5-2011	24-5-2011	Oesterdam	Center	74.008.785	386.729.245	130	135	145	135	125	120	110	110	E	E	3	15		87,00		
11	21-5-2011	24-5-2011	Oesterdam	Center	73.848.741	386.690.051	120	145	150	120	120	110	105	105	E	E	3	17	71,20	70,00	-1,20	-0,40
12	21-5-2011	24-5-2011	Oesterdam	Center	73.703.504	386.668.711	160	195	195	150	130	120	125	150	ENE	ENE	3	32	64,30	85,00	20,70	6,90
13	21-5-2011	24-5-2011	Oesterdam	South	73.550.789	386.641.137	135	160	225	185	155	130	115	110	E	E	3	42	72,00	86,00	14,00	4,67
14	21-5-2011	24-5-2011	Oesterdam	South	73.959.440	386.486.225	110	110	115	117	120	125	120	115	SW	SW	3	8			0,00	0,00
15	21-5-2011	24-5-2011	Oesterdam	South	73.784.822	386.461.279	149	150	150	135	120	125	125	135	ENE	ENE	3	17	66,00	70,00	4,00	1,33

APPENDIX 2 – WEATHER CONDITIONS

Appendix 2 – Weather Conditions

Table 1 weather conditions

Chart 1 The weather conditions between the measuring periods of the mini sand nourishments

This appendix contains the weather conditions for the measuriung period of the mini Sand nourishments in the oesterdam area performed between May 21th and May 24th 2012.

Table 4 weather conditions

Date	Time (h)	Wind speed (m/s)	Wind direction (degree)	Water level (rel) (+150)	Significant wave height (cm)
21-mei-12	11:00	5,8	323	41	45
21-mei-12	11:30	7,4	314	70	41
21-mei-12	12:00	7,4	317	97	38
21-mei-12	12:30	8,4	319	121	34
21-mei-12	13:00	9,3	324	143	37
21-mei-12	13:30	8,8	326	169	38
21-mei-12	14:00	9,1	329	201	39
21-mei-12	14:30	8	327	245	33
21-mei-12	15:00	8,5	323	299	36
21-mei-12	15:30	7,9	319	341	37
21-mei-12	16:00	8,3	326	360	36
21-mei-12	16:30	7,5	326	360	38
21-mei-12	17:00	8,4	319	343	35
21-mei-12	17:30	9,1	323	309	33
21-mei-12	18:00	8,4	325	268	33
21-mei-12	18:30	8,1	319	229	29
21-mei-12	19:00	7	325	192	30
21-mei-12	19:30	7,8	320	155	30
21-mei-12	20:00	7	318	121	35
21-mei-12	20:30	7,3	317	85	37
21-mei-12	21:00	5,5	316	50	38
21-mei-12	21:30	6,3	306	20	40
21-mei-12	22:00	6,5	307	2	37
21-mei-12	22:30	5,7	306	5	39
21-mei-12	23:00	6	311	26	40
21-mei-12	23:30	5,8	315	55	39
22-mei-12	0:00	5,1	330	83	33
22-mei-12	0:30	6	325	108	33
22-mei-12	1:00	5,3	318	131	30
22-mei-12	1:30	6,7	324	154	33
22-mei-12	2:00	6,7	332	185	35
22-mei-12	2:30	6,6	326	228	34
22-mei-12	3:00	7,7	327	284	32
22-mei-12	3:30	6	335	336	31
22-mei-12	4:00	7,1	323	361	29
22-mei-12	4:30	8,2	324	370	29
22-mei-12	5:00	7,1	330	358	27
22-mei-12	5:30	8	333	330	28
22-mei-12	6:00	8,1	330	290	28

22-mei-12	6:30	8,9	326	251	27
22-mei-12	7:00	7,8	330	213	28
22-mei-12	7:30	6,4	332	176	28
22-mei-12	8:00	7,1	330	141	31
22-mei-12	8:30	7,1	316	106	30
22-mei-12	9:00	6	317	70	37
22-mei-12	9:30	5,9	316	37	32
22-mei-12	10:00	6,1	308	14	37
22-mei-12	10:30	5,3	307	5	36
22-mei-12	11:00	4,5	281	18	39
22-mei-12	11:30	7,9	278	43	41
22-mei-12	12:00	8,1	280	71	40
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22-mei-12	13:00	8	277	121	39
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22-mei-12	14:00	9	279	167	39
22-mei-12	14:30	8,2	273	197	37
22-mei-12	15:00	8,1	275	240	36
22-mei-12	15:30	7,3	281	293	32
22-mei-12	16:00	7,9	282	337	30
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22-mei-12	17:00	7,6	288	355	28
22-mei-12	17:30	8,4	283	337	27
22-mei-12	18:00	7,4	278	302	27
22-mei-12	18:30	8,1	283	261	26
22-mei-12	19:00	7,4	279	222	30
22-mei-12	19:30	7,2	280	184	30
22-mei-12	20:00	6,9	284	147	29
22-mei-12	20:30	7	287	112	29
22-mei-12	21:00	5,6	283	75	32
22-mei-12	21:30	5,7	268	38	39
22-mei-12	22:00	6	279	5	35
22-mei-12	22:30	6,9	288	-17	38
22-mei-12	23:00	6,7	294	-18	36
22-mei-12	23:30	5,9	291	-1	36
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23-mei-12	1:30	4	269	102	31
23-mei-12	2:00	4,2	257	128	34
23-mei-12	2:30	4,7	267	159	35
23-mei-12	3:00	4	260	204	33
23-mei-12	3:30	4,1	258	260	34
23-mei-12	4:00	3,7	257	312	29

23-mei-12	4:30	4,6	240	341	28
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23-mei-12	5:30	5,4	241	343	27
23-mei-12	6:00	4,9	238	318	28
23-mei-12	6:30	4,8	234	279	27
23-mei-12	7:00	5,1	224	239	27
23-mei-12	7:30	4,1	244	201	27
23-mei-12	8:00	4,3	236	164	29
23-mei-12	8:30	4,2	225	130	28
23-mei-12	9:00	4	230	95	28
23-mei-12	9:30	4,5	240	60	38
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23-mei-12	10:30	4,5	226	-1	33
23-mei-12	11:00	4,8	243	-10	35
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23-mei-12	12:30	3,7	235	51	39
23-mei-12	13:00	4,1	249	78	43
23-mei-12	13:30 *	1,5	291	101	35
23-mei-12	14:00	3,7	295	124	35
23-mei-12	14:30	4	298	148	35
23-mei-12	15:00	4,1	301	178	36
23-mei-12	15:30	4,6	302	222	36
23-mei-12	16:00	4,5	300	273	41
23-mei-12	16:30	3,4	305	317	32
23-mei-12	17:00	4,2	302	337	32
23-mei-12	17:30	4,1	294	340	31
23-mei-12	18:00	4,6	307	324	31
23-mei-12	18:30	4,8	324	290	36
23-mei-12	19:00	3,5	330	249	36
23-mei-12	19:30	4	319	210	35
23-mei-12	20:00	3,1	338	172	36
23-mei-12	20:30	2,7	346	137	41
23-mei-12	21:00	2,8	324	102	44
23-mei-12	21:30	2,9	309	66	45
23-mei-12	22:00	3,3	283	29	39
23-mei-12	22:30	3,8	318	-5	39
23-mei-12	23:00	3,9	306	-30	43
23-mei-12	23:30	4,5	291	-35	51
24-mei-12	0:00	2	346	-21	47
24-mei-12	0:30	1,9	323	5	* * * * *
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24-mei-12	01:30 *	1,6	354	61	42
24-mei-12	02:00 *	1,6	315	86	36

24-mei-12	2:30	2,4	354	112	37
24-mei-12	3:00	2,8	320	143	35
24-mei-12	3:30	3,3	295	187	42
24-mei-12	4:00	2,7	281	242	41
24-mei-12	4:30	2,7	287	292	46
24-mei-12	5:00	3,5	312	324	37
24-mei-12	5:30	2,8	344	336	39
24-mei-12	6:00	2,1	22	330	39
24-mei-12	6:30	1,2	23	307	36
24-mei-12	7:00	1,9	2	272	37
24-mei-12	7:30	1,7	334	232	32
24-mei-12	8:00	2,4	346	194	42
24-mei-12	8:30	2	318	158	41
24-mei-12	9:00	2,5	308	123	41
24-mei-12	9:30	2,9	291	89	36
24-mei-12	10:00	4	284	54	43
24-mei-12	10:30	4,7	285	21	39
24-mei-12	11:00	5,6	292	-5	40
24-mei-12	11:30	6,1	292	-16	43
24-mei-12	12:00	7,1	291	-9	58
24-mei-12	12:30	7,3	292	13	* * * * *
24-mei-12	13:00	7,1	297	39	* * * * *
24-mei-12	13:30	7,4	300	67	54
24-mei-12	14:00	7,1	304	90	44
24-mei-12	14:30	6,5	303	112	40

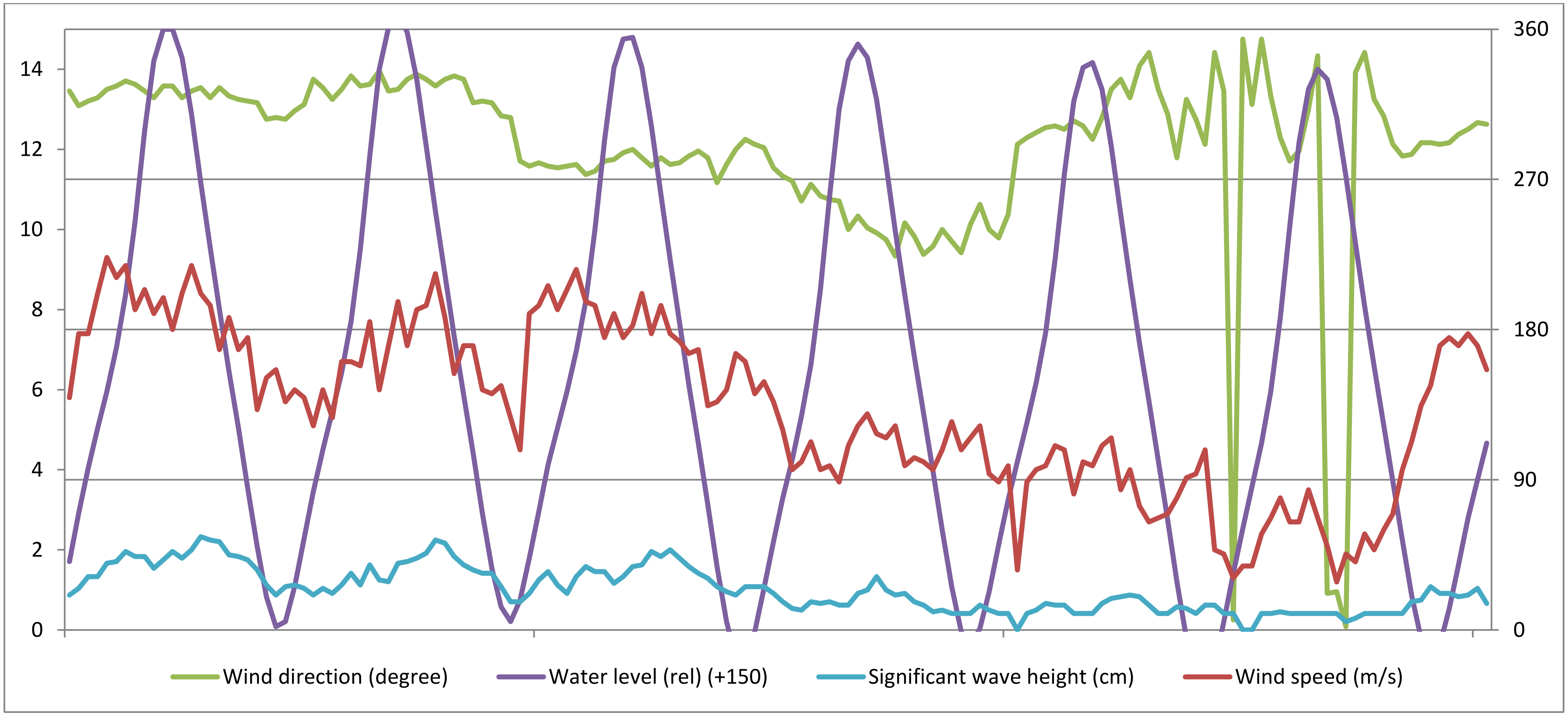

Chart 15 The weather conditions between the measuring periods of the mini sand nourishments

DELTA ACADEMY