Morphological **I**mpacts and **CO**astal **R**isks induced by **E**xtreme storm events

Stand van zaken September 2010

P. Haerens and A. Bolle

International Marine & Dredging Consultants

MICORE – Status September 2010

- Overview of MICORE project:
  - Main goals
  - WP1 – Historical Storms
  - WP2 – Data standards
  - WP3 – Site monitoring
  - WP4 – Models and impacts
  - WP5 – Warning System
  - WP6 - Dissimination

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MICORE – Status September 2010

- Overview of MICORE project:
  - Main goals :

"The primary goal of the MICORE project is to develop and demonstrate on-line tools for reliable predictions of the morphological impact of storm events in support of civil protection mitigation strategies."

"Morphological models will be linked to wave and surge forecasting models to demonstrate a real-time warning system and to implement its usage within Civil Protection agencies."

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MICORE – Status September 2010

- Overview of MICORE project:
  - Main goals
  - **WP1 – Historical Storms**
  - WP2 – Data standards
  - WP3 – Site monitoring
  - WP4 – Models and impacts
  - WP5 – Warning System
  - WP6 - Dissemination

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MICORE – Status September 2010

- WP1 – Historical Storms:
  - Aim:
    - *“Collect site specific metocean and morphological data in support of WP4”*
  - By:
    - Analysis of historical storms
    - Identification of critical storm threshold
    - Climate change impacts on storm occurrence
    - Upload of data on historical storms

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- WP1 – Historical Storms:
  - Results:
    - Analysis of historical storms:
      - Hs, max
      - WL
      - Duration
      - Induced wave energy
    - If available time series in the database

Nº	Date	Hs,max [m]	WL [m TAW]	Duration [Hours]	Wave Energy [J/m²]	Winter
1	06/Feb/1984	4.32	5.21	12.25	6.27E+06	1984
2	23/Nov/1984	4.81	5.63	4.50	4.95E+06	1985
3	15/Jan/1986	3.95	5.24	2.00	3.17E+06	1986
4	20/Oct/1986	4.00	5.50	0.25	2.52E+06	1987
5	01/Nov/1986	3.76	5.30	0.25	2.08E+06	
6	18/Dec/1986	4.36	5.02	13.00	4.00E+06	
7	15/Jan/1987	4.17	3.97	17.50	3.75E+06	
8	10/Feb/1988	4.23	5.07	4.00	4.08E+06	1988
9	29/Feb/1988	4.18	4.73	24.25	4.90E+06	
10	20/Dec/1988	3.81	4.74	0.25	1.93E+06	
11	14/Feb/1989	3.94	5.37	2.50	2.19E+06	1989
12	25/Jan/1990	5.08	4.92	11.50	4.08E+06	1990
13	12/Feb/1990	4.05	5.20	0.75	2.88E+06	
14	15/Feb/1990	3.80	4.82	0.25	2.25E+06	
15	26/Feb/1990	4.70	5.76	42.25	5.20E+06	
16	01/Mar/1990	4.70	5.47	5.25	5.95E+06	
17	10/Dec/1990	4.47	3.92	10.50	4.76E+06	1991
18	12/Dec/1990	4.47	5.16	5.75	4.38E+06	
19	06/Jan/1991	4.26	5.00	3.75	3.15E+06	
20	06/Oct/1992	3.86	3.80	0.75	4.50E+06	1993
21	14/Nov/1993	5.31	5.97	19.50	3.49E+06	1994
22	28/Jan/1994	4.08	5.88	9.75	4.31E+06	
23	01/Jan/1995	4.12	5.85	11.25	4.01E+06	1995
24	12/Jan/1995	4.20	4.47	8.75	3.33E+06	
25	26/Jan/1995	4.11	4.20	4.50	3.35E+06	
26	19/Feb/1996	4.78	5.34	30.50	4.82E+06	*1996*
27	29/Aug/1996	4.95	5.33	18.00	2.84E+06	1997
28	28/Oct/1996	4.64	5.65	3.75	3.27E+06	
29	04/Jan/1998	3.88	4.60	0.75	4.00E+06	1998
30	08/Oct/1998	3.97	5.34	1.50	2.08E+06	1999
31	24/Dec/1999	3.99	5.24	2.00	2.67E+06	2000
32	28/May/2000	3.96	4.34	1.50	1.68E+06	2001
33	29/Oct/2000	4.13	4.55	1.25	3.65E+06	
34	08/Nov/2001	4.47	4.83	17.25	3.31E+06	2002
35	26/Oct/2002	4.38	5.00	0.46	2.83E+06	2003
36	20/Dec/2003	3.80	5.43	0.50	2.52E+06	2004
37	07/Feb/2004	4.10	5.44	-	-	
38	13/Nov/2004	3.80	5.73	0.50	1.96E+06	2005
39	17/Dec/2004	3.84	5.38	0.50	1.68E+06	
40	14/Feb/2005	4.24	5.09	3.25	3.83E+06	
41	17/Dec/2005	3.92	5.43	2.00	2.93E+06	2006
42	09/Nov/2007	4.69	5.93	11.25	4.47E+06	2007

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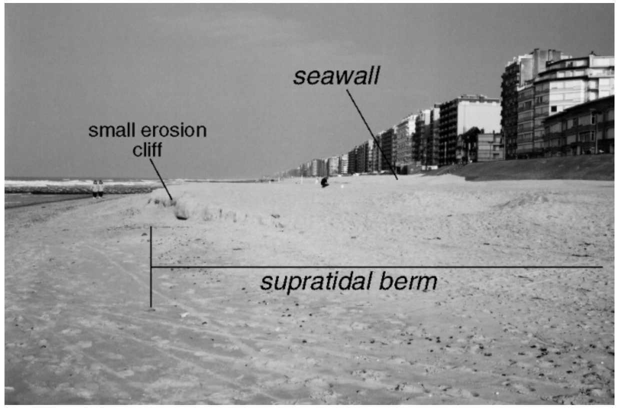
- WP1 – Historical Storms:
  - Results:
    - Identification of critical storm threshold:
    - Comparison of available volume changes with occured storm periods, for 10 coastal areas, 12.2 km

Selected area	Coastal Section	Geographical name	Coastal length [m]	Observations since
1	7 - 12	Verkaveling Westhoek, De Panne	1420	1983
2	22 - 25	Sint-Idesbald, Koksijde	1010	1983
3	26 - 31	Koksijde Bad	1125	1983
4	40 - 43	Oostduinkerke Bad	965	1983
5	60 - 63	Nieuwpoort, east of Ijzermonding	815	1983
6	83 - 87	Middelkerke Bad	1745	1983
7	104 - 108	Mariakerke beach	1770	1983
8	151 - 158	De Haan, centre	1606	1981
9	173 - 176	Wenduine Bad	850	1981
10	202 - 208	Blankenberge, De Fonteintjes	894	1979
Total analysed coastal length			12200	



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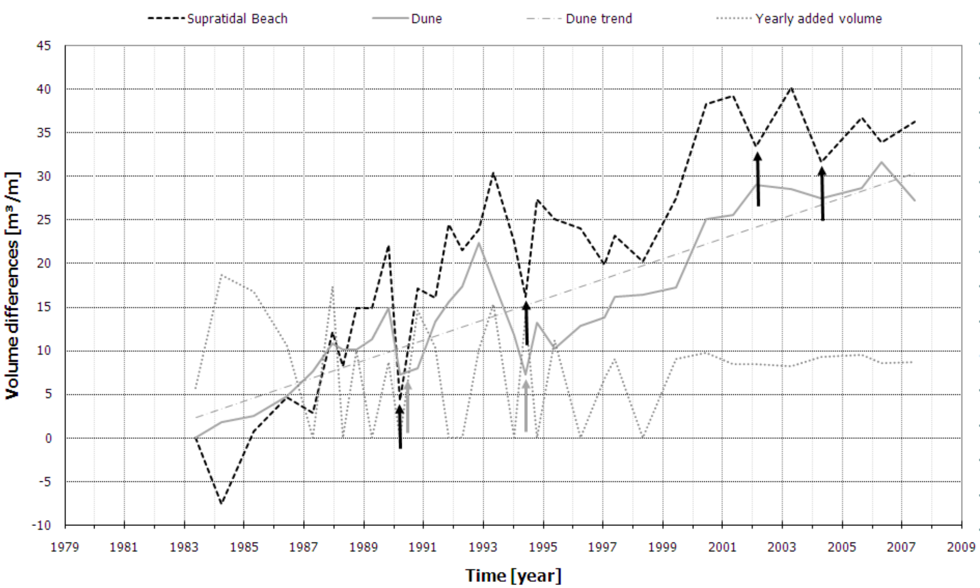
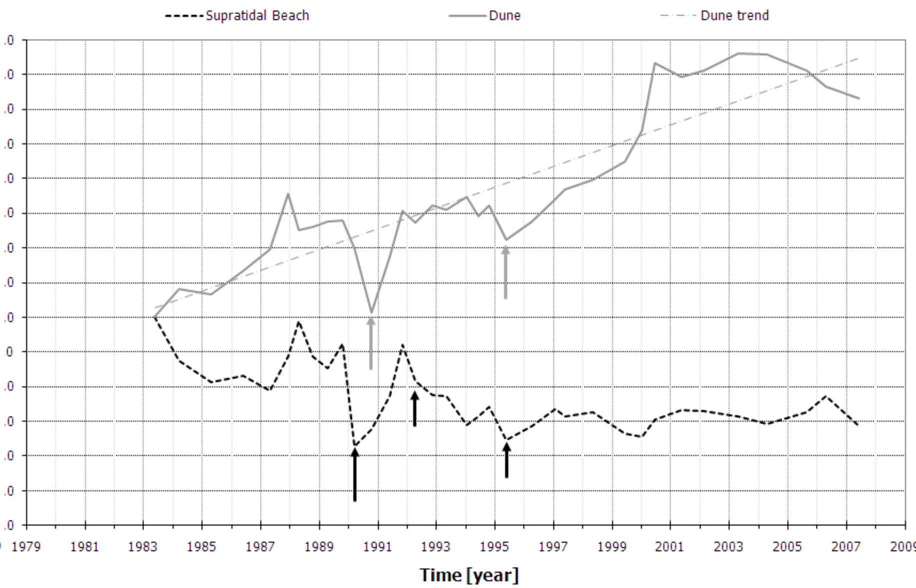
- WP1 – Historical Storms:
  - Results:
    - Identification of critical storm threshold: Volume variations

Selected area	1982 SB	1982 D	1983 SB	1983 D	1984 SB	1984 D	1985 SB	1985 D	1986 SB	1986 D	1987 SB	1987 D	1988 SB	1988 D	1989 SB	1989 D	1990 SB	1990 D	1991 SB	1991 D	1992 SB	1992 D	1993 SB	1993 D	1994 SB	1994 D
1	(*)	(*)															15	10			10					
2	(*)	(*)															20	10							15	10
3	(*)	(*)																							10	5
4	(*)	(*)									10	20			10	5	15								10	5
5	(*)	(*)			15	5					15	15					15	10							5	15
6	(*)	(*)									15	5					10	5								
7	(*)	(*)			10						5						10						5	5		
8	15	5			25	5	15	10			20	5					35	15							15	
9	10										5						20	5					10	5	10	5
10											10	5					15	20							10	10

Selected area	1995 SB	1995 D	1996 SB	1996 D	1997 SB	1997 D	1998 SB	1998 D	1999 SB	1999 D	2000 SB	2000 D	2001 SB	2001 D	2002 SB	2002 D	2003 SB	2003 D	2004 SB	2004 D	2005 SB	2005 D	2006 SB	2006 D	2007 SB	2007 D
1	5	5																								
2															5				10							
3	10	5																								
4															10				10							
5	10																									
6									10																	
7																									10	
8	20								10		20		10		15										10	
9			5	5							15	5														
10									5																	





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- WP1 – Historical Storms:
  - Results:
    - Identification of critical storm threshold:
      - Analysis main table
      - Threshold=combination
        H_s > 4.1 m
        WL > +5.0 mTAW
        Storm duration > 9.5hrs
      - To compare RP1 year:
        - H_s = 4.50m
        - WL = 5.40m TAW

Nº	Date	$H_{s,max}$ [m]	WL [m TAW]	Duration [Hours]	Energy +/-1.5d [J/m²]	Number of affected areas	Maximum Erosion [m³/m]	Winter
1	06/Feb/1984	4.32	5.21	12.25	3.74E+06	3.00	25	1984
2	23/Nov/1984	4.81	5.63	4.50	3.20E+06	1.00	15	1985
3	15/Jan/1986	3.95	5.24	2.00	2.23E+06	0.00	0	1986
4	20/Oct/1986	4.00	5.50	0.25	1.86E+06	7.00	20	1987
5	01/Nov/1986	3.76	5.30	0.25	1.37E+06			
6	18/Dec/1986	4.36	5.02	13.00	2.43E+06			
7	15/Jan/1987	4.17	3.97	17.50	3.16E+06			
8	10/Feb/1988	4.23	5.07	4.00	2.86E+06	0.00	0	1988
9	29/Feb/1988	4.18	4.73	24.25	3.59E+06			
10	20/Dec/1988	3.81	4.74	0.25	1.42E+06			
11	14/Feb/1989	3.94	5.37	2.50	1.71E+06	1.00	10	1989
12	25/Jan/1990	5.08	4.92	11.50	2.71E+06	9.00	35	1990
13	12/Feb/1990	4.05	5.20	0.75	1.91E+06			
14	15/Feb/1990	3.80	4.82	0.25	1.35E+06			
15	26/Feb/1990	4.70	5.76	42.25	3.23E+06			
16	01/Mar/1990	4.70	5.47	5.25	3.41E+06			
17	10/Dec/1990	4.47	3.92	10.50	2.10E+06	0.00	0	1991
18	12/Dec/1990	4.47	5.16	5.75	2.64E+06			
19	06/Jan/1991	4.26	5.00	3.75	2.16E+06			
20	06/Oct/1992	3.86	3.80	0.75	2.84E+06	2.00	10	1993
21	14/Nov/1993	5.31	5.97	19.50	3.20E+06	7.00	15	1994
22	28/Jan/1994	4.08	5.88	9.75	2.63E+06			
23	01/Jan/1995	4.12	5.85	11.25	2.87E+06	4.00	20	1995
24	12/Jan/1995	4.20	4.47	8.75	2.33E+06			
25	26/Jan/1995	4.11	4.20	4.50	1.81E+06			
26	19/Feb/1996	4.78	5.34	30.50	3.63E+06	*1.00*	*5*	*1996*
27	29/Aug/1996	4.95	5.33	18.00	2.52E+06	0.00	0	*1997*
28	28/Oct/1996	4.64	5.65	3.75	2.46E+06			
29	04/Jan/1998	3.88	4.60	0.75	2.73E+06	0.00	0	1998
30	08/Oct/1998	3.97	5.34	1.50	1.36E+06	3.00	10	1999
31	24/Dec/1999	3.99	5.24	2.00	1.84E+06	2.00	20	2000
32	28/May/2000	3.96	4.34	1.50	1.36E+06	1.00	10	2001
33	29/Oct/2000	4.13	4.55	1.25	2.56E+06			
34	08/Nov/2001	4.47	4.83	17.25	2.72E+06	3.00	15	2002
35	26/Oct/2002	4.38	5.00	0.46	2.12E+06	0.00	0	2003
36	20/Dec/2003	3.80	5.43	0.50	2.16E+06	2.00	10	2004
37	07/Feb/2004	4.10	5.44					
38	13/Nov/2004	3.80	5.73	0.50	1.21E+06	0.00	0	2005
39	17/Dec/2004	3.84	5.38	0.50	1.22E+06			
40	14/Feb/2005	4.24	5.09	3.25	3.10E+06			
41	17/Dec/2005	3.92	5.43	2.00	2.36E+06	0.00	0	2006
42	09/Nov/2007	4.69	5.93	11.25	2.62E+06	2.00	10	2007

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MICORE – Status September 2010

- Overview of MICORE project:
  - **Main goals**
  - **WP1 – Historical Storms**
  - **WP2 – Data standards**
  - WP3 – Site monitoring
  - WP4 – Models and impacts
  - WP5 – Warning System
  - WP6 - Dissemination

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MICORE – Status September 2010

- WP2 – Data Standards:
  - Aim:
    - *The objective of this work package is to take-in, store, process and disseminate physical data for each pilot site (bathymetries, waves, tides etc.) in a form convenient for the assessment of storm risk along the European coast.*
  - By:
    - Open Source initiative:
      - Open Earth Tools
      - Meta-data follow INSPIRE regulations
      - Network Common Data Form (NetCDF)

MICORE – Status September 2010

- Overview of MICORE project:
  - Main goals
  - WP1 – Historical Storms
  - WP2 – Data standards
  - **WP3 – Site monitoring**
  - WP4 – Models and impacts
  - WP5 – Warning System
  - WP6 - Dissemination

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MICORE – Status September 2010

- WP3 – Site monitoring:
  - Measurements undertaken
  - Registered storms during the monitoring period
  - Hydrodynamic campaign
  - Preliminary results
  - Analysis report

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Status WP3 - Information based on Table 1.4 (DoW pg. 27)

(light grey)	According DoW
(dark grey)	Extention of duration of measurement campaign
(light green)	Executed measurments
(red)	Storm events
(blue)	Executed analysis and data transfer
(green)	Planned analysis and data transfer

WP3 - ITEMS	Applicabel for IMDC	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WP3 - Set up of program		According DoW : month 1 - 6																							
WP3 - Storm Specific monitoring									According DoW : 6 to 18																
Long term monitoring																									
Topography	x					17/10/2008	26/11/2008	16/12/2008		12/02/2009		28/04/2009					10/09/2009					-	05/03/2010	30/04/2010	
Bathymetry	x					17/10/2008		17/12/2008		13/02/2009		14/04/2009					23/09/2009					25/02/2010	10/03/2010	29/04/2010	
Shoreline	x					17/10/2008		17/12/2008		13/02/2009		28/04/2009					23/09/2009								
Hydrodynamics																									
Offshore waves	x									By wave rider bouy at Akkaert (22m depth)															
Nearshore waves										By wave rider bouy at Oostende Noodstrand (6m depth)															
Tide	x										By tidal gauge in Ostend														
Wind	x									By wind measurements at Westhinder (offshore)															
STORM OCCURANCE							20/11/2008		23/01/2009	10/02/2009												?? 28/02/2010 ??			
Post Storm Surveys																									
Profile evolution	x						26/11/2008		12/02/2009													YES			
Morphological changes	x						26/11/2008		12/02/2009													YES			
Socio-economic impacts	x						NA		NA													NA			
Maximum Water run-up	x						NA		NA													NA			
Storm processes							NA		NA													NA			
Intensive campaign																									
Additional hydrodynamics	x								Measurement of waves, currents and turbidity																
Profile pre/post storm	x					17/10/2008	26/11/2008		16/12/2008	12/02/2009												YES			
Recovery processess	x																					YES			
WP3 - Processing data											According DOW : month 6 -23														
Morphology	x																								
Hydrodynamics	x																								
WP3 - Transfer to databank											According DOW : month 6 - 24														
Morphology																									
Topography	x																								
Bathymetrmy	x																								
Cross-shore profiles	x																								
Sediment analysis	x																								
Hydrodynamics																									
Offshore waves	x																								
Nearshore waves	x																								
Currents	x																								
Water levels	x																								
Wind	x																								
WP3 - Deliverables																									
D3.1 Report	x																								
D3.2 - Short term measurements	x																								
D3.3 - Morphological data	x																								
[illegible]	x																								

Surveys : 8 topographic & 8 bathymetric surveys
Continuous registration of forcing mechanisms
Additional hydrodynamic campaign from Dec 08 until Apr 09
Processing data = Nov 09 – August 10
Transfer of data = May 10 – September 10

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- WP3 – Site monitoring:
  - Registered storms during the monitoring period:
    - Based on thresholds for morphological change:
      - 20/11/2008: $H_{s,max}$ = 4.1m & WL = +4.5m TAW
      - 23/01/2009: $H_{s,max}$ = 4.5m & WL = +4.1m TAW
      - 10/02/2009: $H_{s,max}$ = 4.1m & WL = +5.7m TAW
      - 28/02/2010: $H_{s,max}$ = 3.0m & WL = +5.6m TAW
    - Only storm of 10/02/2009 > threshold values for waves and water level => duration +/- 10hours

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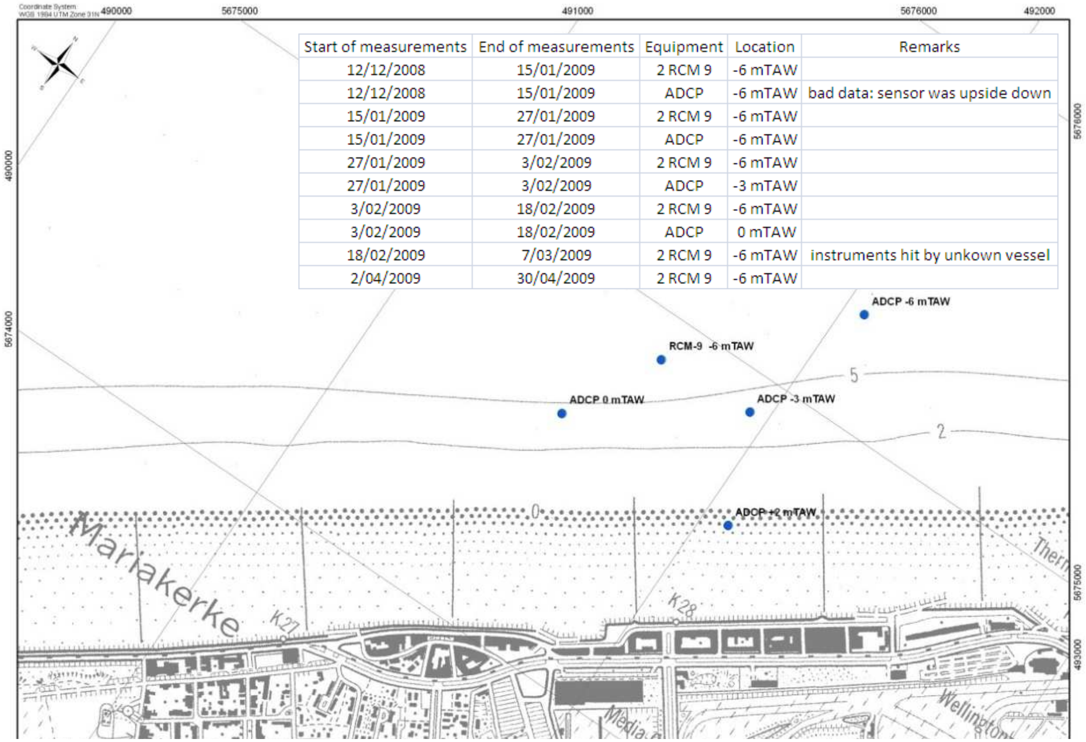
- WP3 – Site monitoring:
  - Hydrodynamic campaign:
    - Measurement of wave parameters and current velocities at different locations => the factual data report



Start of measurements	End of measurements	Equipment	Location	Remarks
12/12/2008	15/01/2009	2 RCM 9	-6 mTAW	
12/12/2008	15/01/2009	ADCP	-6 mTAW	bad data: sensor was upside down
15/01/2009	27/01/2009	2 RCM 9	-6 mTAW	
15/01/2009	27/01/2009	ADCP	-6 mTAW	
27/01/2009	3/02/2009	2 RCM 9	-6 mTAW	
27/01/2009	3/02/2009	ADCP	-3 mTAW	
3/02/2009	18/02/2009	2 RCM 9	-6 mTAW	
3/02/2009	18/02/2009	ADCP	0 mTAW	
18/02/2009	7/03/2009	2 RCM 9	-6 mTAW	instruments hit by unkown vessel
2/04/2009	30/04/2009	2 RCM 9	-6 mTAW	

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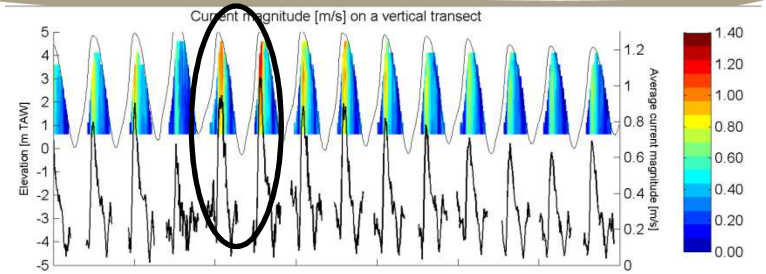
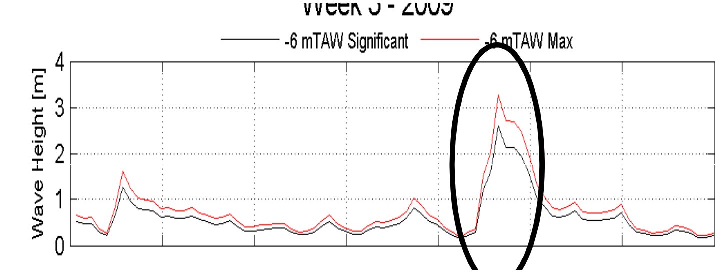
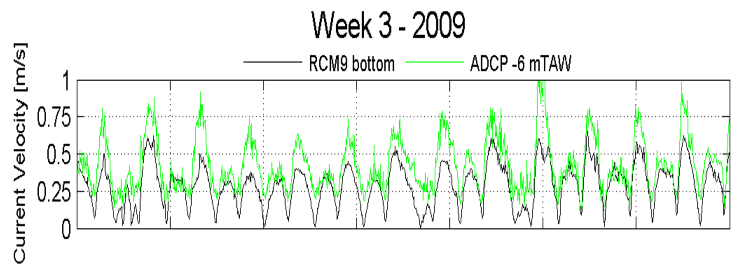
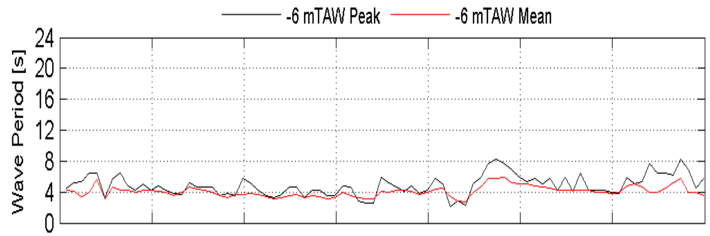
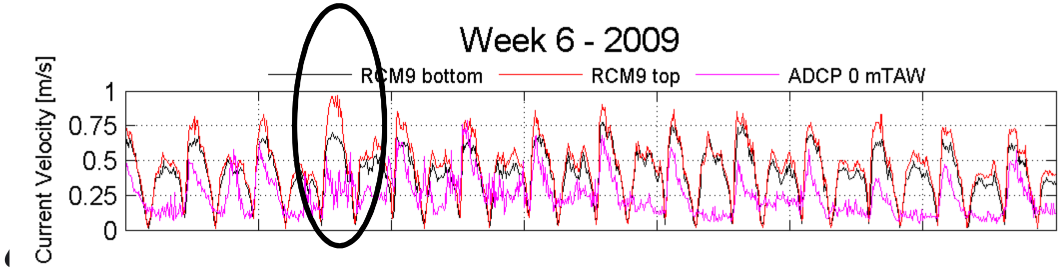
- WP3 – Site monitoring:
  - Hydrodynamic campaign:
    - Influences of the storms of Jan & Feb 09 are visible in the records:
      - Current velocities:
        - Increase during storms ±20%
        - Cross-shore variations
      - SSC.
    - Valuable input for WP4 tests











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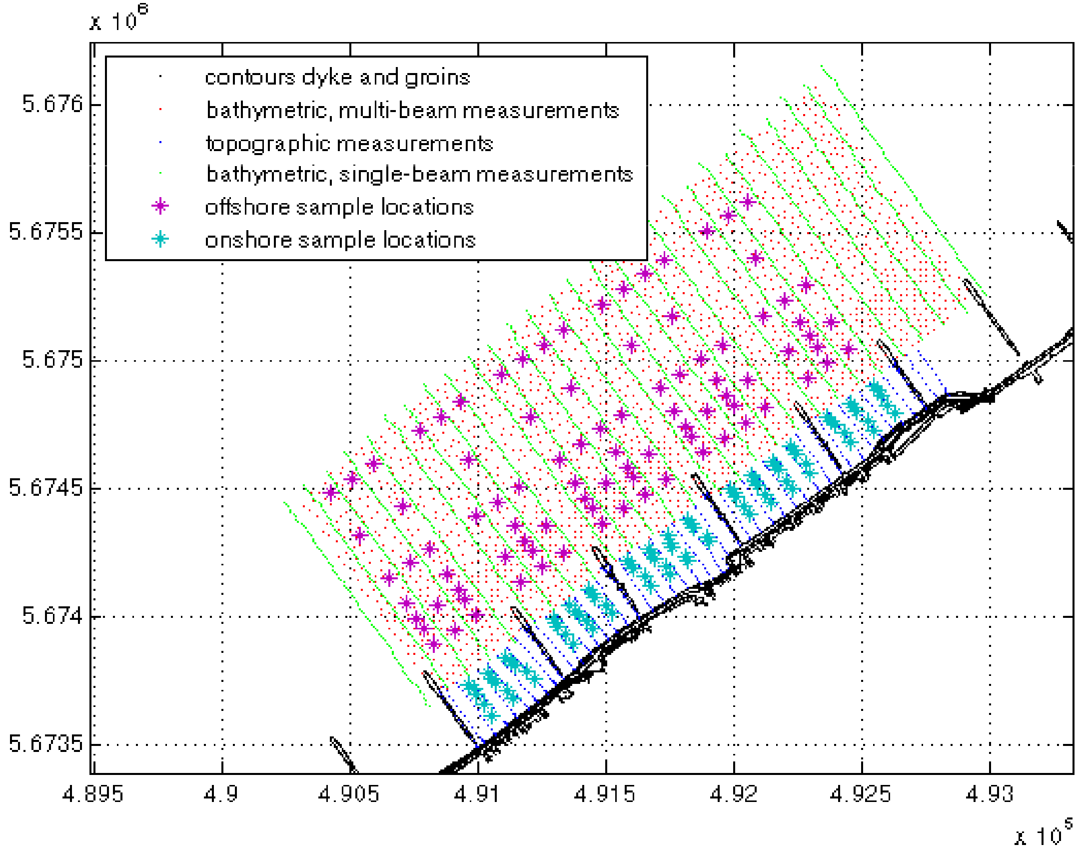
- WP3 – Site monitoring:
  - Preliminary results:
    - Set-up:



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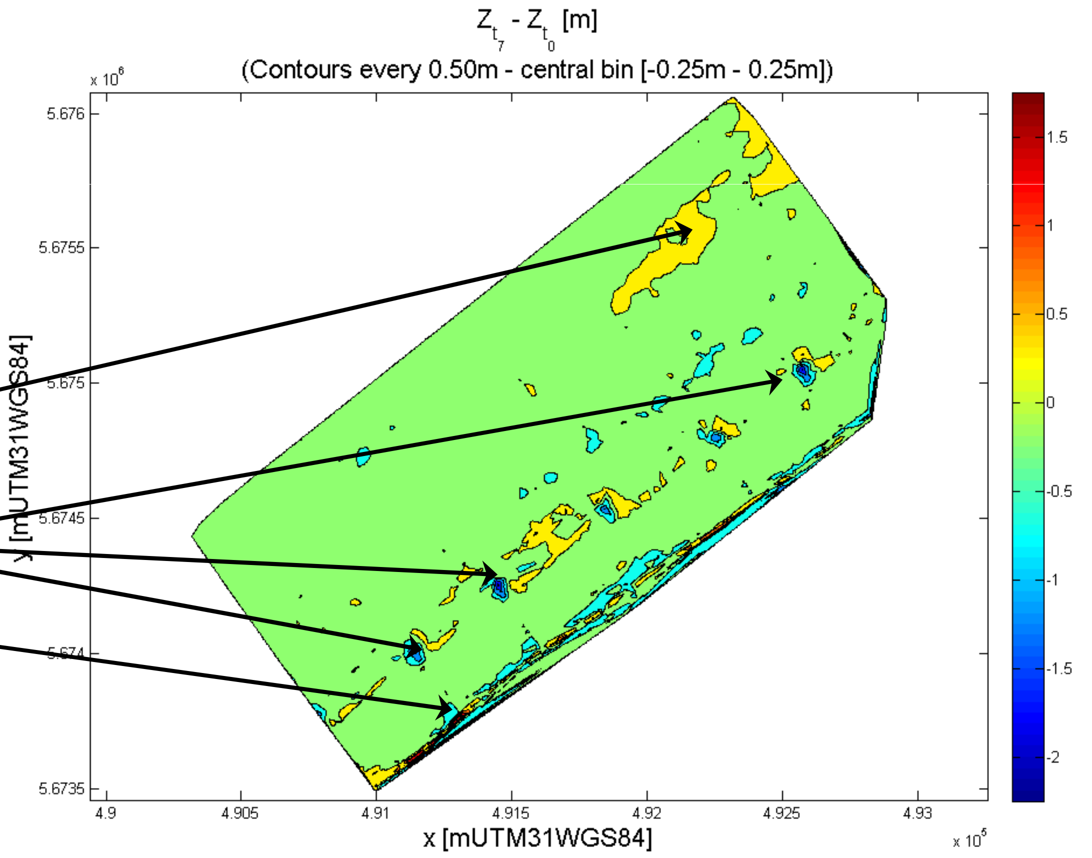
- WP3 – Site monitoring:
  - Preliminary results
    - DTM October 2008 - March 2010 = in general < 0.5m
    - Local changes:
      - At the connection with Ostend
      - At the groins = scouring
      - Along the dyke



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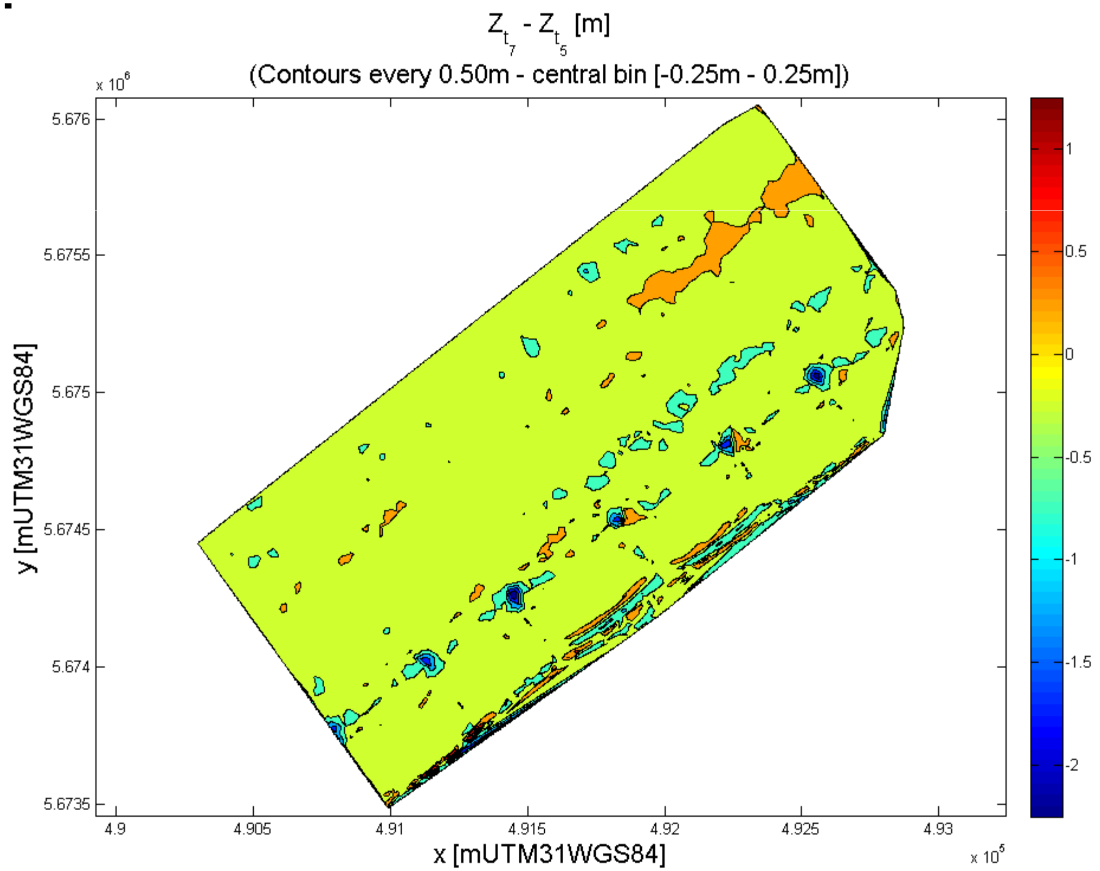
MICORE – Status September 2010

- WP3 – Site monitoring:
  - Preliminary results:
    - DTM Sept. 2009 – March 2010 = in general < 0.5
    - Same pattern:
      - Near Ostend
      - At the groins
      - Along the dykes
    - Includes effects of Xynthia storm



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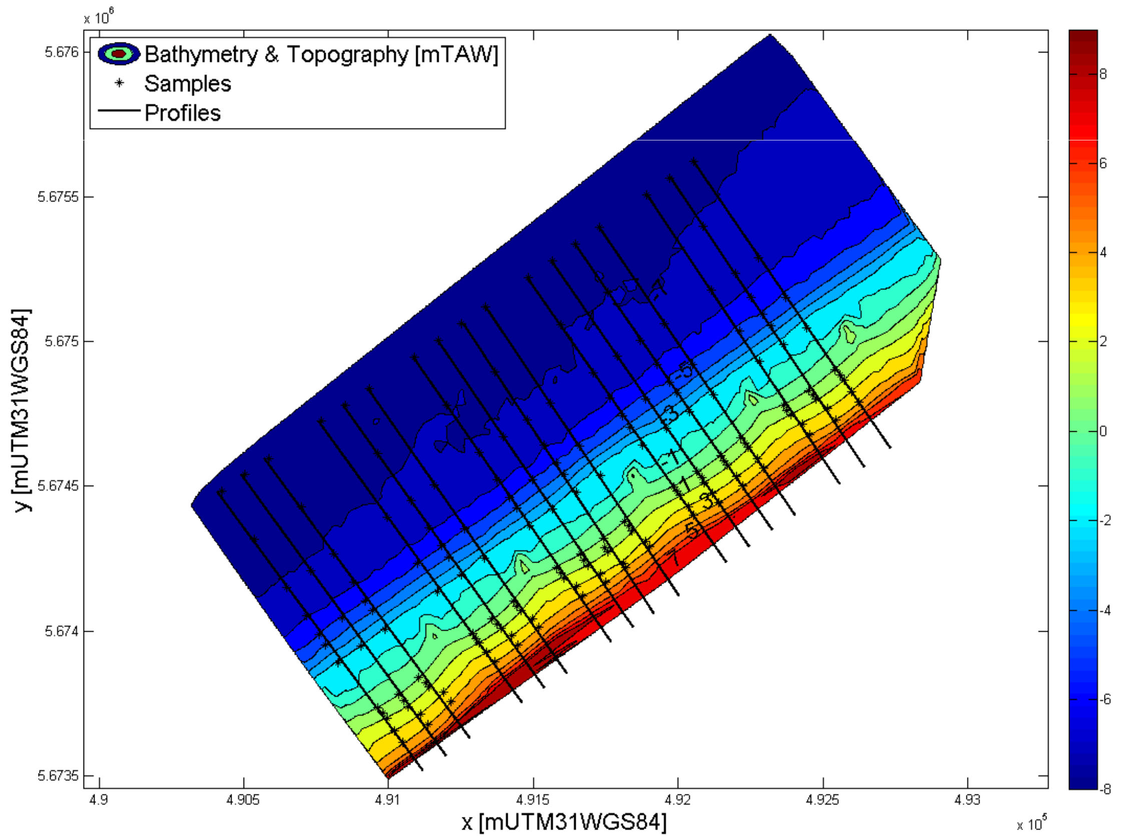
MICORE – Status September 2010

- WP3 – Site monitoring:
  - Preliminary results:
    - Profile positions:
      - 17 profiles
      - N°1 SW
      - N°17 NE



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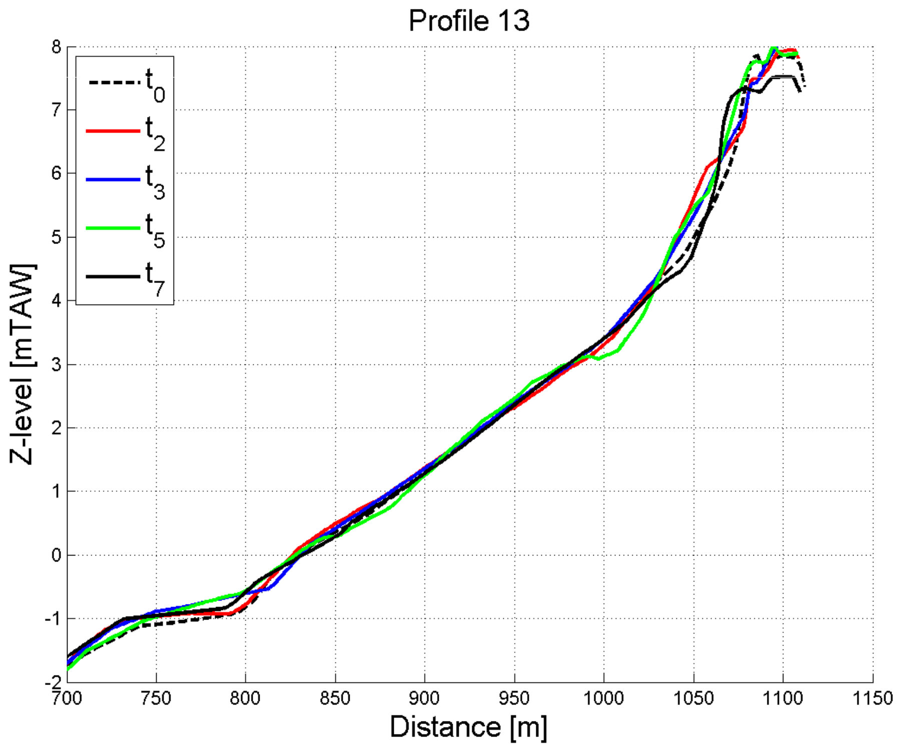
- WP3 – Site monitoring:
  - Profiles can be separated into 4 zones:
    - Active zone between +8 and +3mTAW, max. changes = +/-1m, near the dyke
    - Neglectible changes between +3 & 0mTAW
    - Small changes between 0 and -3/4m
    - Neglectible changes between -3/-4m and -8mTAW



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- WP3 – Site monitoring:
  - ***NO SIGNIFICANT STORMS*** for <u>uniform</u> significant morphological changes nor damage along the project site were registered during monitoring period
  - Available historical data will be used for WP4

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MICORE – Status September 2010

- Overview of MICORE project:
  - Main goals
  - WP1 – Historical Storms
  - WP2 – Data standards
  - WP3 – Site monitoring
  - **WP4 – Models and impacts**
  - WP5 – Warning System
  - WP6 - Dissemination

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MICORE – Status September 2010

- WP4 – Models and impacts:
  - Aim:

"The objective of this work package is to use, validate and extend the free-ware X-Beach model for various European coastal hazard situations and compare its outputs with off-the-shelf packages."

"The end goal is to incorporate jointly-developed (between partners) algorithms into one shared operational forecast/predictive model..."

"To connect off-the-shelf models and X-Beach model with the socio-economic impact via Storm Impact Indicators (SIIs)."

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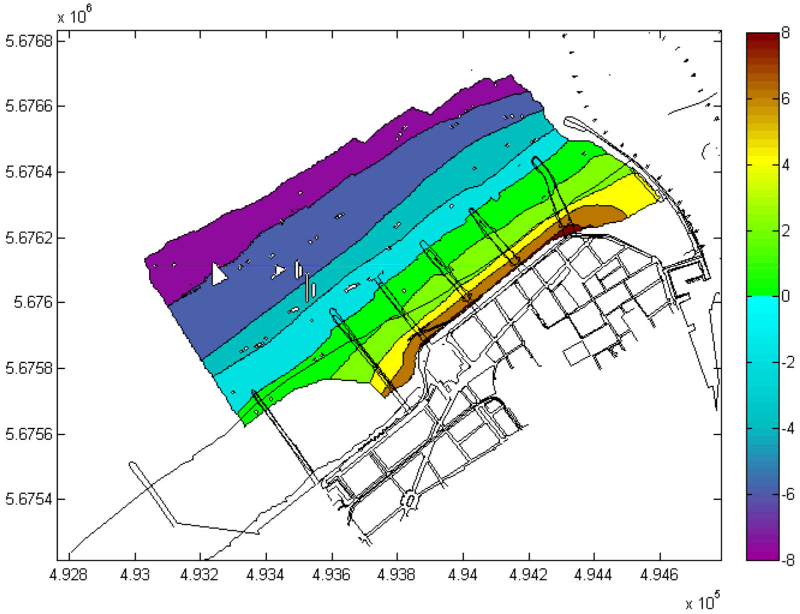
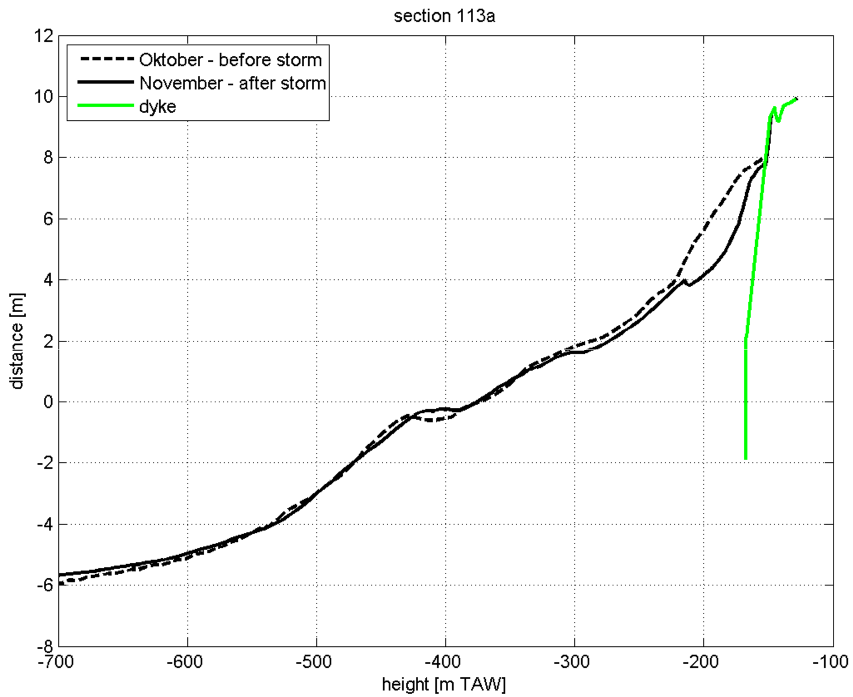
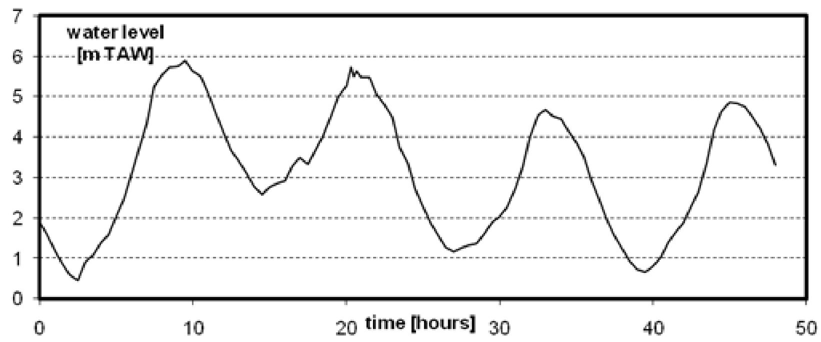
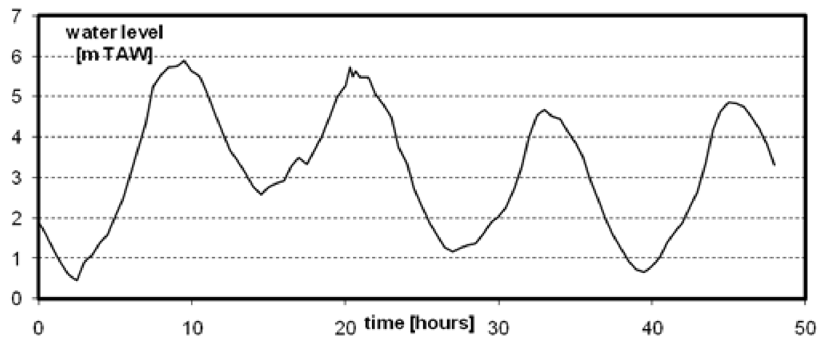
Storm November 2007

→ Data Ostend Noodstrand









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Results to date

- Set-up of **XBeach model for Ostend centre**
  - 1D / 2D (+ extended model)
  - Including sea wall → hard structure
  - Historical storm
  - Test new XBeach versions & other parameter settings
- Comparison with
  - measurements (beach levels)
  - Durosta

→ calibration

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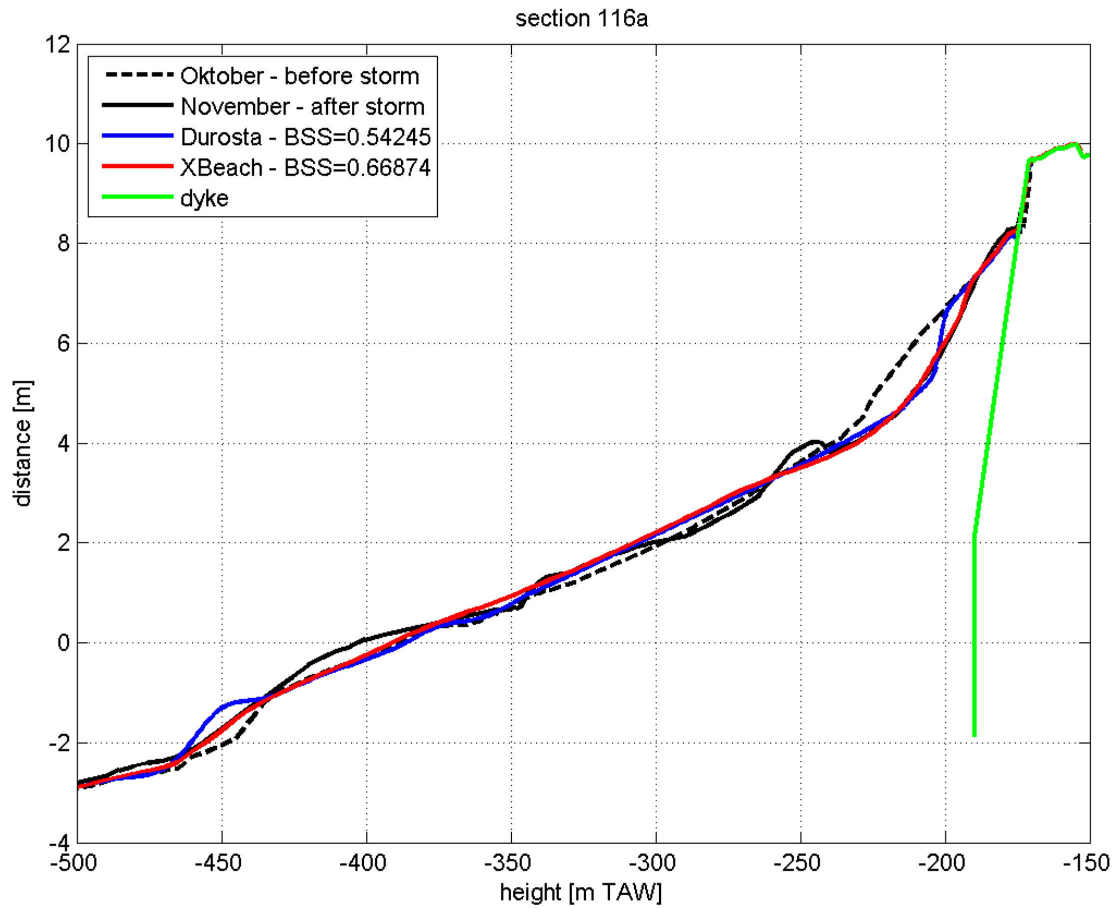
Results to date

1D model – Ostend center

→ In general the performance of XBeach is at least as good as Durosta for beach erosion where no "hard structure" (e.g. dykes) are involved.

Section [number]	***Briar Skill Score (BSS)***	
	Durosta	XBeach
113a	0.26	0.42
114a	0.45	0.34
114b	0.44	0.31
115a	0.55	0.81
115b	0.45	0.65
116a	0.54	0.67
116b	0.51	0.57
117a	0.40	0.47
average	**0.45**	**0.53**



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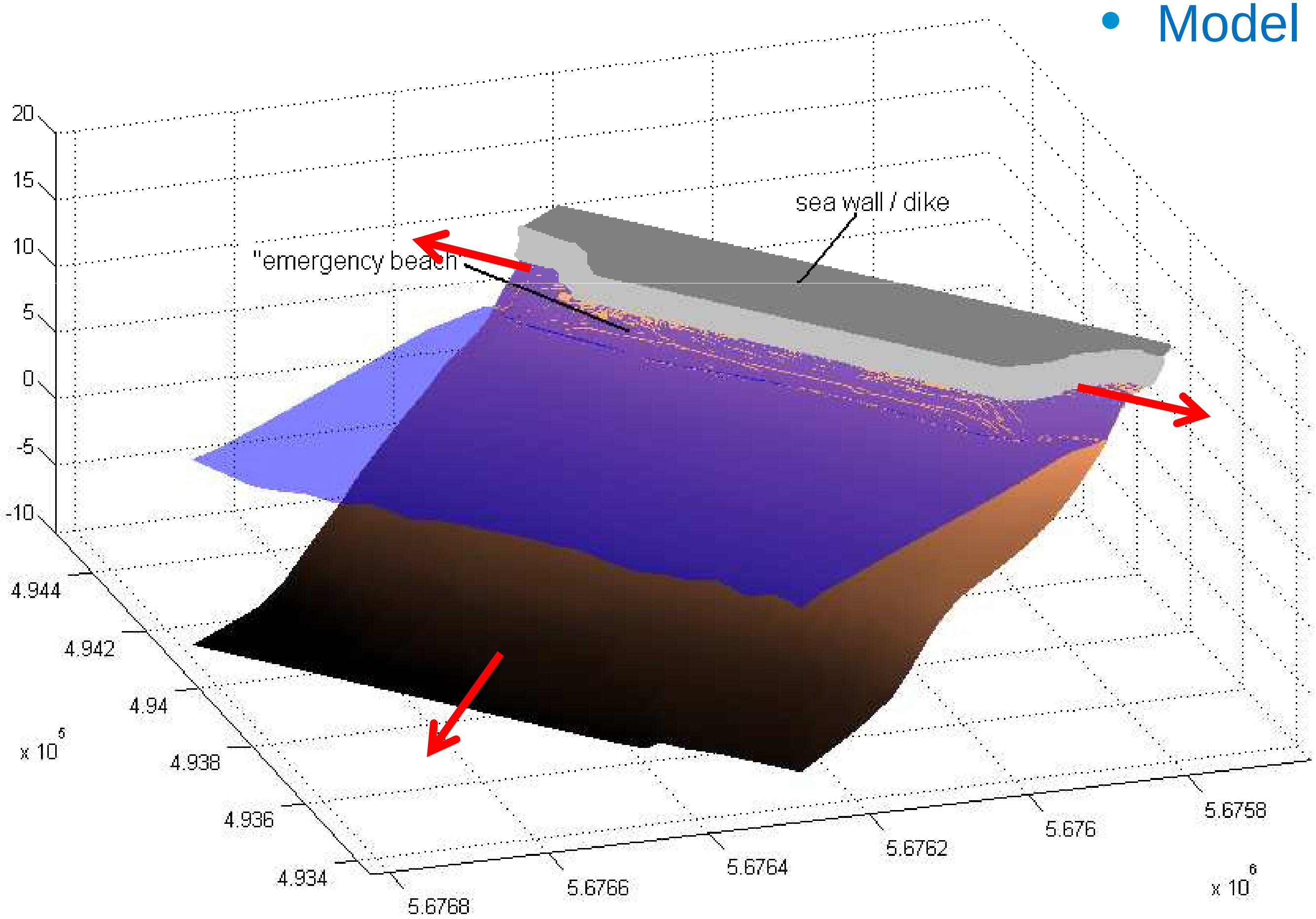
Results to date

2D model – Ostend centre

- Model has been extended



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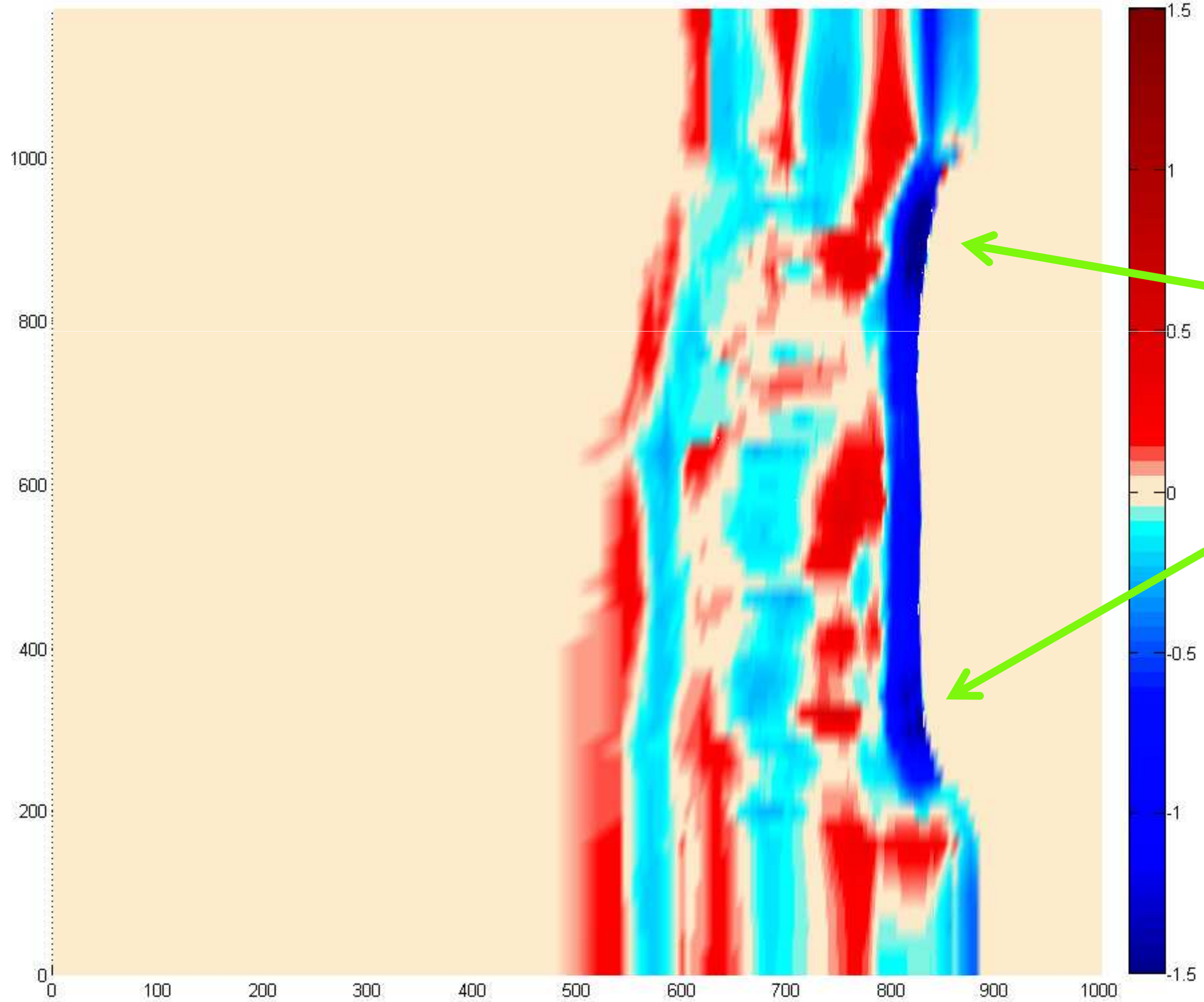
2D model – Ostend centre



locally more erosion

cfr. 2D effects for dune erosion (van Thiel de Vries, ICCE 2010)

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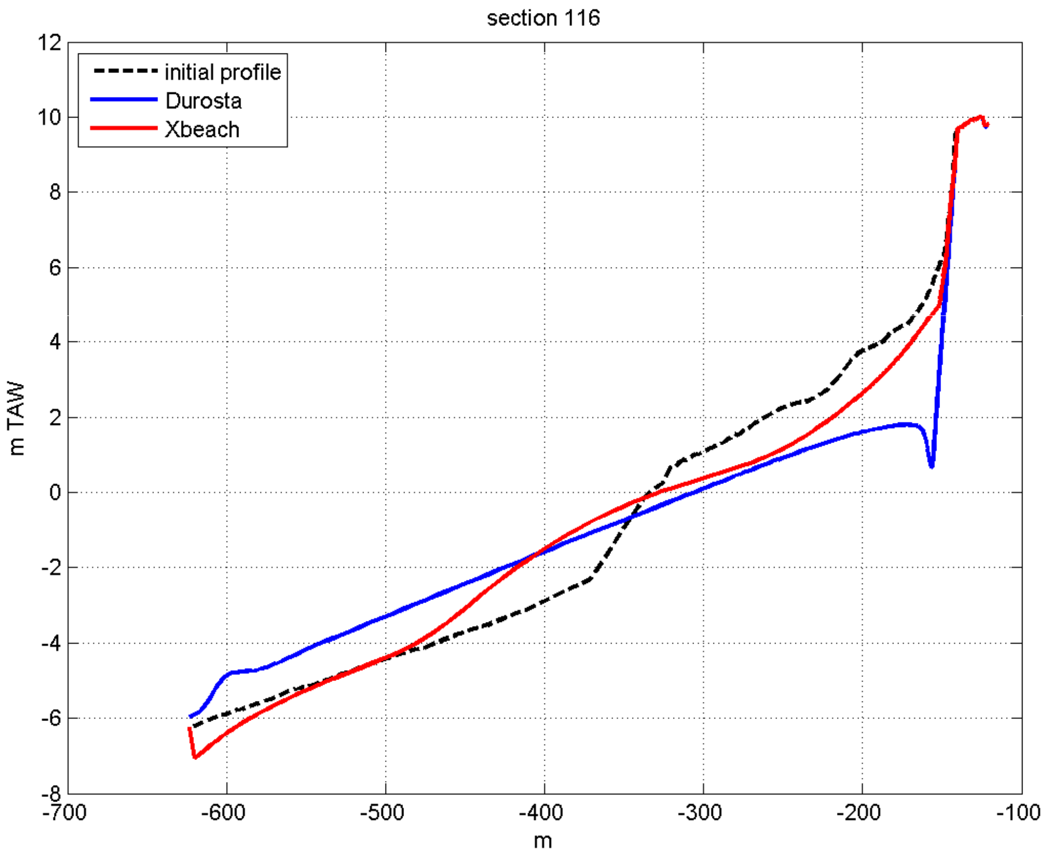
Results to date

1D model – Ostend centre

- 1000-years storm event
  - 1D XBeach model for Ostend centre
  - Erosion reaches the dyke
- Comparison with
  - Durosta

→ in XBeach, smaller amount of erosion close to the dyke

→ reflection?



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Next steps (I)

Continue with Ostende centre model

- To investigate storm impact on beach + sea wall
- Historical dataset
- Improve models

→ effect of hard structures (i.e. reflection) needs to be improved

→ improve stability and calcalution speed of 2D model

→ include currents

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- WP4 – Models and impacts:
  - X-Beach model:
    - the erosion profile near and above the water level is well reproduced. In general the performance of XBeach is at least as good as Durosta for beach erosion where no “hard structure” (e.g. dykes) are involved.
    - Quite some difference are noticed between Durosta and X-Beach when hard structures are exposed => the most important being the smaller amount of erosion found with XBeach close to the dyke.
    - Xbeach does predict 2D effects at curved sections => added value for complex situations.

MICORE – Status September 2010

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  - WP6 - Dissemination

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- WP5 – Warning System:
  - Aim:
    - Scope = <u>not</u> to develop a fully on-line operational real time warning system
    - Main goal = <u>to demonstrate</u> the capability of a prototype model train for the test site to predict the impact of extreme storm events
    - Final deliverable of WP5 = *<u>a demonstration test case</u> in which the partners demonstrate that an operational model for the forecast of morphological change at their study site is <u>feasible, reliable and possible to set up and ready to be further developed</u> if any official institution should ask for it*

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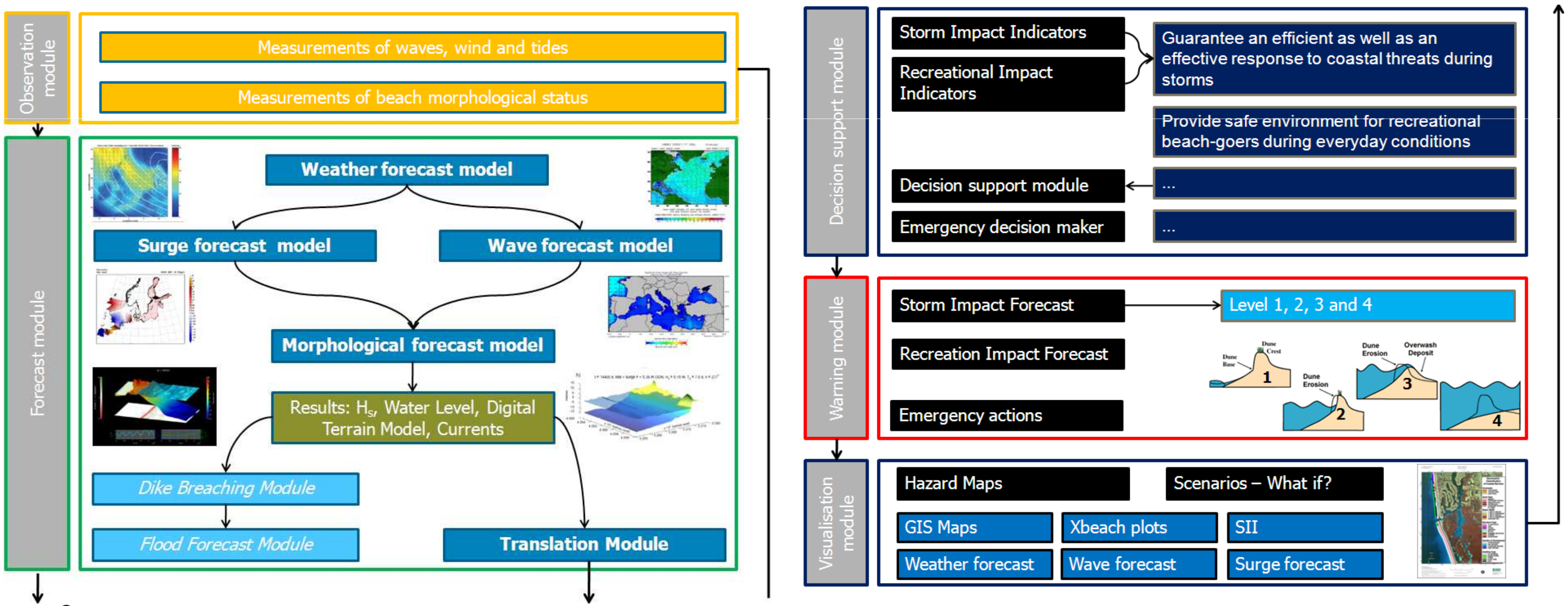
- WP5 – Warning System:
  - How? => based on a generic concept:



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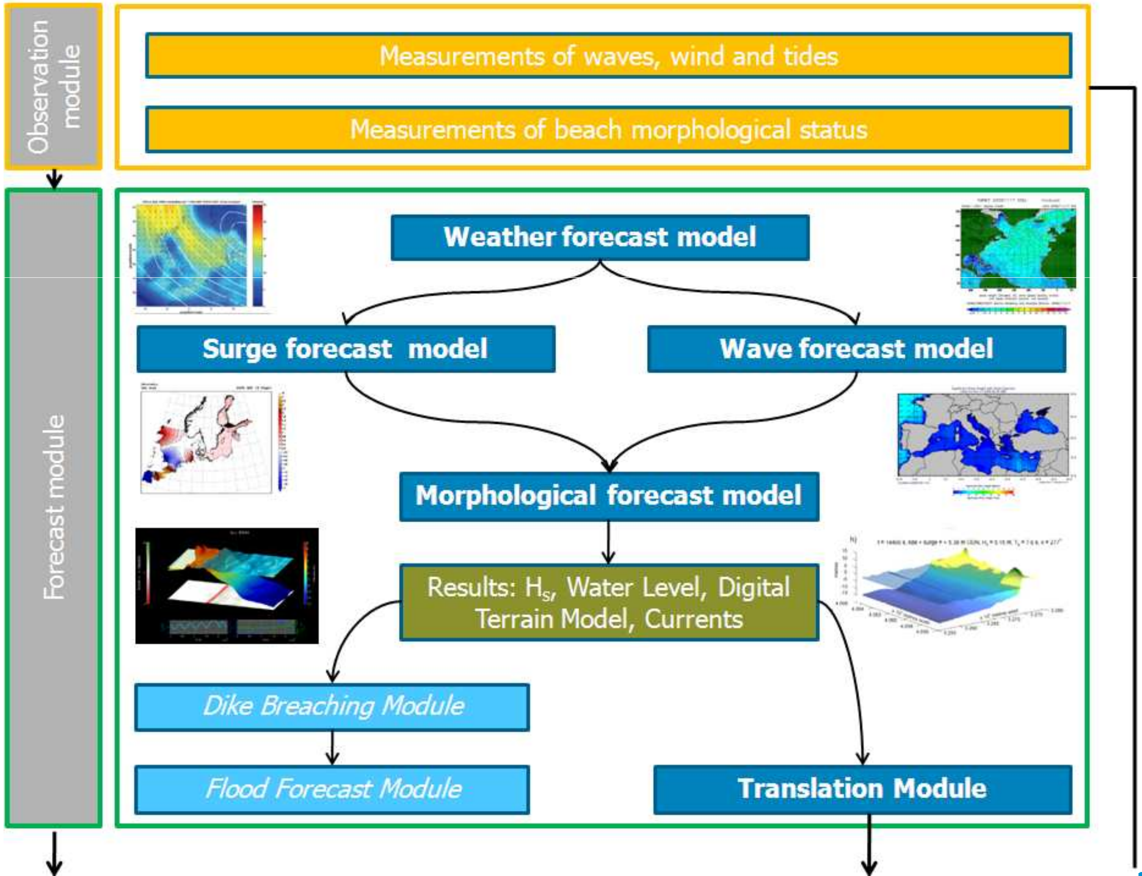
- WP5 – Warning System:



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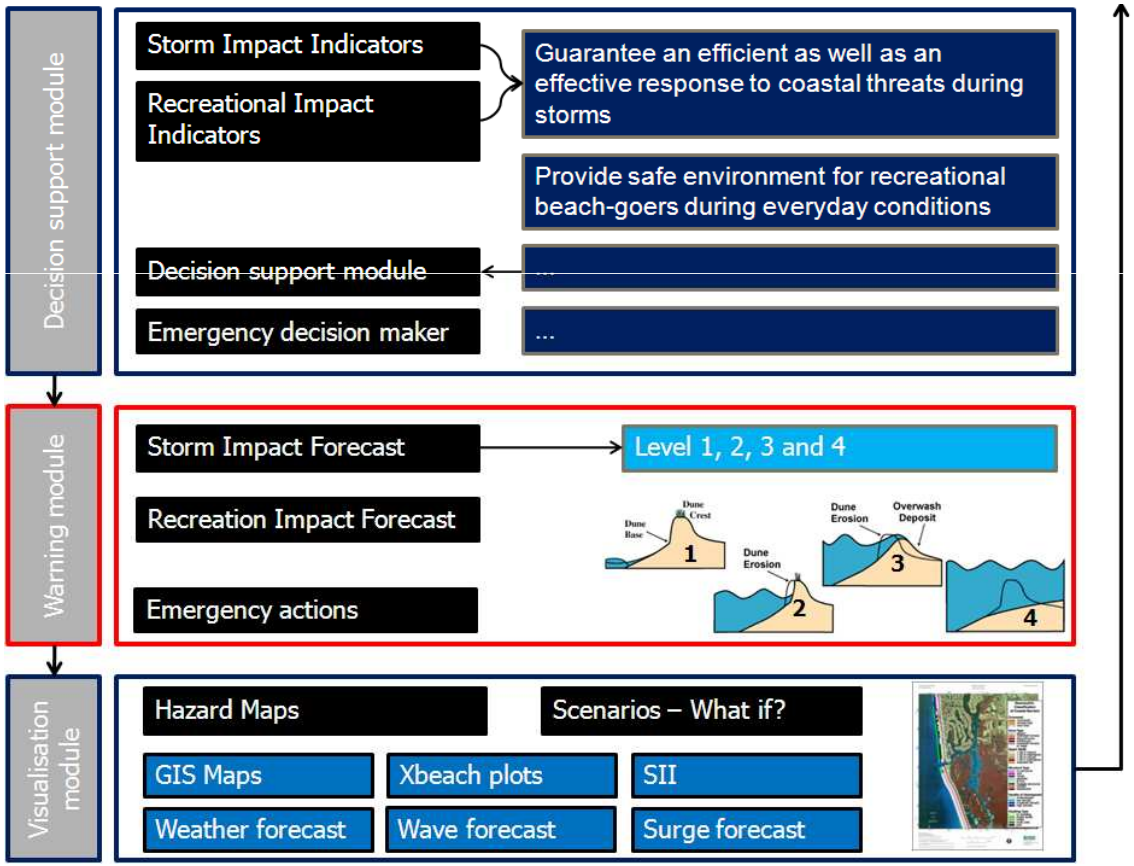
- WP5 – Warning System:



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- WP5 – Warning System:
  - Forecast module:
    - Translate metocean conditions to X-Beach input
    - Translate X-Beach output into physical parameters:
      - Overtopping discharge Q (l/m/s)
      - Run-up level
      - Dune feet position
      - Erosion volume
      - Dune volume above storm surge level
      - Others?
    - Physical parameters => input for the SIIs

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- WP5 – Warning System:
  - Visualisation module:
    - Web-based GIS maps:
      - Input:
        - Forecast of waves, tides + (currents)
      - For each SII:
        - Maps with colour bars/code

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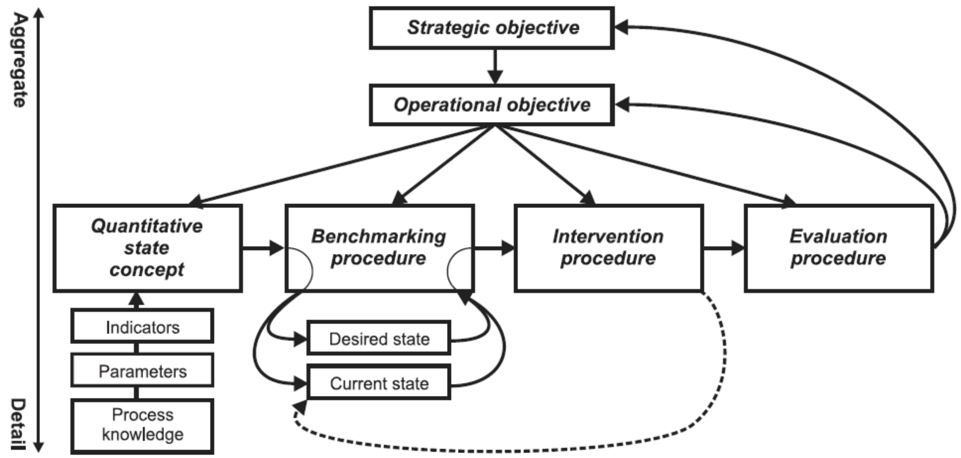
- WP5 – Warning System:
  - Storm impact indicators:
    - are **NOT** physical parameters
    - to make the essential components of coastal decision making explicit
    - q methodology aimed at structuring the end user-specialist interaction in application oriented knowledge development settings act indicators



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- WP5 – Warning System:
  - Storm impact indicators for Mariakerke beach:

Strategic Objective	Operational Objective	QSC	Benchmarking Desired State	Benchmarking Current State	Intervention Procedure	Evaluation Procedure
Provide a sufficient wide beach to ensure recreational activities	Keep the beach wide enough by artificial nourishments during the low recreational season	Space time maps with the (horizontal) position of the high water line and the beach width	Dry beach width > x m	Model results for the position of the high water line (LW line is defined by its vertical level (0m TAW), dus niet relevant)	Based on the predicted dry beach width, prepare beach nourishment campaigns	After storms check wether the predicted decrease in dry beach width was accurate & the evaluation of the strategic objective may result in change of the beach nourishment program
Guarantee a sufficient safe beach to ensure recreational activities	Keep the beach free from scarps and erosion cliffs (wet (=intertidal) and dry beach)	Space time maps with the indication of scarps and erosion cliffs	height of erosion cliffs < x m	Model results for the position, amount and magnitude of erosion cliffs and beach scarps	Based on the predicted beach profile, prepare intervention	Check predicted beach status with status after major storms
Guarantee an efficient as well ass effective respons to threaths for infrastructures on the beach	Organise evacuation or protection of material and infrastructure under threat	Space time maps with the indication of the run-up level and beach erosion	Run-up level < x m & beach erosion front more than x m away from inrastructure	Online predictions of run-up level and beach erosion front	Based on predicted level organise evacuation of infrastructure on the beach or plan protective actions	Infrastructure is safe when situated above a certain run-up level, evacuate when higher run-up levels are expected.
Guarantee sustainable safety of (inhabited) property	Keep the overtopping discharge (over the dyke) sufficiently low	Along dike vs. time prediction of the overtopping discharge Q	Safety is guaranteed as long as the overtopping discharge Q < x l/m/s	Online prediction of the overtopping discharge as function of time	Start evacuation of buildings if the predicted overtopping discharges are too high	Inhabitants are safe below the critical overtopping discharge, and evacuated when higher overtopping discharges are expected.

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- WP5 – Warning System:
  - Oportunities to improve model train:
    - More detailed forecast of wave and tide
      - Wave: periods and direction
      - Tide: tidal curve
      - Hourly values?
    - Measured data available to verify model capabilities
    - 2D based XBeach
    - Forecast of November 2007?

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MICORE – Status September 2010

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  - **WP5 – Warning System**
  - **WP6 - Dissemination**

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- WP6 – Dissemination:
  - Elements:
    - Project web-site: www.micore.eu
    - Training sessions for scientists: OpenEarth & XBeach
    - Training sessions for end-users: to be scheduled
    - SII reporting
    - Journal Special Issues:
      - Geomorphology =>storm thresholds = under review
      - Natural Hazards => global warming = in compilation
    - Final project meeting = workshop => May 2010

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