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Review on available information on flora, fauna and environment (DanWEC Vaekstforum 2011)

Arianna Azzellino Lucia Margheritini Morten Lauge Pedersen



Aalborg University Department of Civil Engineering Water and Soil

DCE Technical Report No. 143

Review on available information on flora, fauna and environment (DanWEC Vaekstforum 2011)

by

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March 2012

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Preface

The Danish Wave Energy Centre (DanWEC) has been established in 2009 because of participated desire to market the trial wave energy projects which are already in Hanstholm and others to come. The DanWEC is a part of Hanstholm harbour in the North-West of Denmark.

The Center will contribute at creating a local base for knowledge, education and possibly a workplace which will be leased out to trial projects. It is therefore likely that different developers will deploy their wave energy devices during the next years in this location and therefore detailed knowledge on a number of environmental and physical parameter is necessary.

The present report has been prepared by Lucia Margheritini (lm@civil.aau.dk). Morten Lauge Pedersen (mlp@civil.aau.dk) is responsible for the data fetching and review; Arianna Azzellino (ara@civil.aau.dk) is responsible for preliminary data analysis. The report should function as a review and assessment of the existing documents and present knowledge on information at the DanWEC location.

The present report has been prepared under the project No. 834101 "DanWEC Vaekstforum 2011", task 4: "Collection and presentation of basic data on flora and fauna for the DanWEC site at the Port of Hanstholm".

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Introduction

Marine Environmental Data are collected as a part of the routine monitoring programme of the marine environment. The programme includes a physical / chemical component and a biological programme. The biological and the physical / chemical parameters are not necessarily sampled at the same stations (Fig. 1). The monitoring data are historical and covers a 20 year span from app. 1987 to 2007. Newer data are probably available but we need to contact local environmental offices to get access to data.



Figure 1. Map of North-Jutland with highlighted data stations of relevance of the DanWEC and Hanstholm.

• Physical / chemical programme

Four are the stations of interest for the Danwec (Table 1). All parameters are sampled in different depths: Top /5-10m/10-15m/15-20m/20-25m (Table 2). All data is available for online database http://www.miljoeportal.dk/Overfladevand/ (Fig 2).

Station	Name	Position	
VIB 2300-23100	1 NM NNW of Hanstholm	8° 35,3' E	57° 08′ N
VIB 2300-23101	4 NM NNW of Hanstholm	8° 34' E	57° 11′ N
VIB 2300-23102	7 NM NNW of Hanstholm	8° 32' E	57° 14′ N
VIB1100-00002	Hanstholm/Thyborøn (Nørre Vorupør)		

Table 2. Physical and Chemical parameters available at the stations.

Parameters					
Physical	Chemical				
Depth	рН				
Wave height	Suspended sediment				
Air temperature	ТОС				
Air pressure	NH ₄ -N				
Wind speed	NO ₂₃ -N				
Wind direction	Tot-N				
Density	PO ₄ -P				
Salinity	Tot-P				
Oxygen	Chloride				
Temperature	Silicon				
Fluorescence	Chlorophyl				

Table 3. Station, period and number of samples (physical and chemical parameters).

Samples						
Station	Sampling period	Number of samples				
VIB 2300-23100	1989 – 2009	162 – 219				
VIB 2300-23101	1989 – 1997	104				
VIB 2300-23102	1989 – 1997	104				
VIB1100-00002	-	-				



Figure 2. Screen dump from the online database of physical / chemical parameters

• Biological programme

The biological parameters are: <u>taxonomic composition</u> and <u>abundance of marine bed invertebrates</u>. Samples are standardized grab samples of equal size. All data is available for online database (Fig 3). <u>http://www.miljoeportal.dk/Overfladevand/</u> Table 4. Relevant stations for acquisition of marine biological Environmental Data at Hanstholm.

Station	Name	Position	
1104	Jammerbugt 1	9° 34,16′ E	57° 15,73′ N
1106	Jammerbugt 2	9° 35,59′ E	57° 16,02' N
1110	Jammerbugt 3	9° 33,05′ E	57° 16,30' N

Table 5. Station, period and number of samples (biological parameters).

Samples						
Station	Sampling period	Number of samples				
1104	1989 – 1996	12				
1106	1989 – 1996	12				
1110	1989 – 1996	12				

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	22	A Find station			Opbyg rep	olikeret prøvetagning	🏟 Tislut skydelæ	re 🏟 Tiklut va	igt 🔽				
Hiljecente	r Aalborg	Område Skagerrak		51	ationsområde	Jammerbugten		Stationsnr	1104				
	Prøveta	igninger		Delprøve S	edment.								
Startdato	Skutdeto	8enækning		Delprøven									
30-04-1997	_			Delprøvenr.	0	Dato 30-04-1997		Faunal	on 🗌 Orig. delprø	ave			
17-04-1936				Preveoplani	naer								
10/04/1994	-			Bunddybde (-	4 Provedvbde (c	m) (m	Konservering	Ethanol				
09.001992	-			Markaudda	(m)	1000		Drawaradekab	Hans				
18,05,1992	-		-	Areal (m ²)	01	0143 Webwee @		Combaidar					
23-04-1991				Acres (114)		VI O VOLINI		oper output					
03-05-1990	-			Geografiske	koordinater		Benærkninger						
12/04/1989			•	Længde	90 3	14,16 Minutter							-
	De	orever	=	Reality	57.0 1	5.73 Minuther							
Delprøve	Pravedato	Orig delprøve		11TM koorde	aler .								
b i	0 30 04 1997												
	1 30-04-1997			Y		x							
	2 30-04-1997			UTM-zone	-								-
	3 30-04-1997		i	-				Induced	0	C	1	Chevelon	
	4 30 04 1997		-11	DMILer	Mnamokoda	Adman .	Oata	fordal Vier	Tary Arka Remedy	Sk (ma)	Vådused (el	Tanuard (a)	Arkewart (r)
	5 30 04 1997		-11	CHO IN.					t angt vangt ing	AC 010	Tool and the	101003150	Partition (2)
	5 30 04 1997		-16					(9	1 (g) (g)				
-	0 00 04 1997		-18	1100000	NENEHIN	Nemertra indet	b) oplyst	6 0.2	S 0.09 0.062	-			
	9 30.04.1997		-16	1910/010	NTOLLOD	Sigaion marnisae	E) opiyot	3 0.4	X 0.051 0.004	-			
1	0 20.04.1927		-16	19323014	NEPH UR	Neprojs cinosa	EI opiyot	7 0,1	2. 0,012 0,000	-			
1	1 31.04 1997		-16	19323020	CDIO MAD	Proje constituencia	El opiyst	8 0,1	5 0,021 0,000	-			
1	2 30-04-1997		-1H	19470010	SPID ROM	Spinnhanan hombury	Ei ophysi	10.0	¥ 0.463 0.405	-			
1	3 30-04-1997		-1H	19490510	MASE NIR	Macelona mirabilis	Fi colut	29.0.3	2 0.08 0.022	-			
1	4 30-04-1997		-11	3700000	TANAIDAX	Tanaidacea indet	Ei oplyst	1 0.0	x 0.000 0.000	-			
1	5 30-04-1997		1	42031010	BATHELE	Bathyporeia elegans	Ej oplyst	6 0,00	0.001 0.000	1			
1	6 30 04 1997			42031020	BATH GUI	Bathyporeia gulliamoonia	ina Ej oplyst	12 0,05	51 0.007 0.001	1	<no data="" td="" to<=""><td>display></td><td></td></no>	display>	
1	7 30-04-1997		_11	42034015	URD GRI	Utothoe grinaldi	Ei oplyst	63 0.1	\$ 0.026 0.007				
1	8 30-04-1997		[42426010	SYNC HAP	Synchelidium haplochele	rs Ej oplyst	23 0.05	56 0.007 0.001				
1	9 30-04-1997		_10	42641020	ATYL SWA	Alaks swannerdami	Ej oplyst	1 0,00	0,000 0,000				
2	0 30-04-1997		_0	66202020	MYSE BID	Mysella bidentata	Ej oplyst	2 0,00	0,00: 0,003	_			
				66203010	TELL FER	Tellinga ferruginosa	Ej oplyst	2 0,00	20,011 0,011	_			
			- H	66405030	SPIS SUB	Spicule subtruncete	Ei oplyst	1 0.06	\$ 0.05 0.045	-			
			- 14	66504030	I HABU FAB	Fabulina tabula	Ej oplyst	46 1.5	1 0.300 0.805	-			
				66604010	CORB GIB	Cobula gbba	Ej oplyst	9 0,0	15 0,005 0,005	-			
			- 14	8.24209	SECHINOCZ	Econocardium sp.	Ej oplyst	4 7,4	6[236]267]	-			
Tiskittet Di	PD652010.	foWinRambi 🔒											

Figure 3. Screen dump from the online database of biological parameters

Biological programme

In this report only the available information about benthos community will be analysed.

Preliminary exploration of the abundance data.

Different different kinds of benthos abundance data are available (biomass1: wet weight; biomass2: dry weight, and biomass3: ashes) but they are strongly correlated (see the correlation matrix shown in Table 6) so all the following analysis concern the Biomasse vådvægt). Due to the strongly asymmetrical distribution of the biomass values a logarithmic transformation (e.g. Log10) was applied obtaining a much more symmetrical distribution which was further splitted by year and by month (Fig. 4).



Figure 4. Frequency distribution of logbiomass 1 by year (rows) and by month (columns). The presence of empty crosstabulations is due to missing data.

Afterwards, by means of a One-Way ANOVA (Rutherford, 2001), the hypothesis that the biomass varies yearly or monthly was tested. ANOVA showed clearly that the biomass values did not significantly change by year or month in the used dataset (Tables 7, 8). Moreover, it was also tested whether the three sampled stations (i.e. 1104, 1106 and 1110) were homogenous in terms of biomass. In this case One-Way ANOVA showed significant differences (Table 9).

Table 6. Matrix of the Pearson's correlation coefficients (available (biomass1: wet weight; biomass2: dry weight, and biomass3: ashes). The significance level (i.e. Sig.) and number of cases (i.e. N) are also shown. The correlation coefficients highly significant (Sig.<0.01) are labeled with the "**" symbol.

	Correlations							
		biomass1	biomass2	biomass3				
biomass1	Pearson correlation	1	,994**	,995**				
	Sig. (2-tails)		,000,	,000				
	Ν	420	420	420				
biomass2	Pearson correlation	,994**	1	,996**				
	Sig. (2-tails)	,000		,000,				
	Ν	420	592	592				
biomass3	Pearson correlation	,995**	,996**	1				
	Sig. (2-tails)	,000	,000					
	Ν	420	592	592				

Table 7. One.-way ANOVA results: the logbiomass1 was tested against the year. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). No statistical difference was assessed.

	One-Way ANOVA (Fixed Factor: Year)								
logbiomass1									
	Sum of the Squares	df	Mean of the Squares	F	Sig.				
Between	6.788	5	1.358	.921	.467				
Within	610.129	414	1.474						
Totale	616.917	419							

Table 8. One.-way ANOVA results: the logbiomass1 was tested against the month. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). No statistical difference was assessed.

One-Way ANOVA (Fixed Factor: Month)								
logbiomass1								
Sum of the Squares df Mean of the Squares F Sig.								
Between	2.560	2	1.280	.869	.420			
Within	614.358	417	1.473					
Totale	616.917	419						

Table 9 One.-way ANOVA results: the logbiomass1 was tested across the sampling stations. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). A statistical difference was assessed.

One-Way ANOVA (Fixed Factor: Stations)								
logbiomass1								
	Sum of the Squares	Df	Mean of the Squares	F	Sig.			
Between	13.351	2	6.676	4.612	.010			
Within	603.566	417	1.447					
Totale	616.917	419						

A following Tukey test for multiple comparisons (Tukey, 1949) showed that station 1110 has a biomass significantly lower (depth: -10 m) that station 1104 (which is the station closer to the shore). While station 1106 (depth:-7 m) is somewhat intermediate between these two and is not significantly different from these (Table 10).

Table 10 Tukey Multiple comparison test. The three stations are compared pairwise. The Significance levels are shown. A significant difference was found between station 1110 and 1104 (in blue).

Multiple comparaisons									
dependent: logbiomass1									
Test: Tukey HSD (Sig. Are shown)									
	(J) Stationsnr								
(I) Stationsnr	1104	1106	1110						
1104		,222	,007						
1106	,222		,273						
1110	,007	,273							



Figure 5 95% Confidence intervals of the means of the three stations. It can be observed that the 95% CI intervals of the stations 1104 and 1110 do not overlap at all. Station 1106 is in between.

Preliminary exploration of the Taxonomic composition.

To explore the differences of the Taxonomic composition a Cluster Analysis was used and a data matrix was prepared to analyze the similarities (see Table 11). A code was created for each station*year combination and the number of individuals belonging to the species (Arstnr.) was counted. In this way the species composition profile per each sample was used to compare the similarities among the stations.

Table 11.	Example of	the data m	atrix used a	as input (of the Clu	uster .	Analysis.	Column	header	show t	the "y	ear_	station"	codes
whereas A	Artsnr. Is th	e code for t	he species.											

Artsnr.	1986_04	1987_04	1990_04		1992_06	1993_06	1994_06		1996_10	1997_10
2010005							2			
3421010										
11000001	6		2	8	8	10	8	6	8	12
18000001							2		0	0
19051535						0				
19106007								2		
19107010	0	0		2	0	4	0	0	4	10
66405020				0						
66405030	0	48	4	0		0		0		2
66405099							2		2	0
66501010	12	14	22	16	22	2	4	20	4	0
66501099						0		14	0	
66503030		0								
66504030	426	218	56	6	32	416	172	42	228	92
66532010						0				
66532099				0						
66560000			0							
66561010	16	0	0	0	0	0	0	0	2	0
66604010								2		18
75101099			0					0	0	0
81000010						0				

103 spp

Hierarchical Cluster Analysis was used (Afifi and Cark, 1996). As metric of similarity the Euclidean Distance was used. The Ward method was chosen as agglomeration criterion.

As the attached dendrogram shows (Fig. 6) the stations are quite homogeneous in terms of taxonomic composition, since the "ouliers" seem to be confined to some years (e.g. 1994, 1995, 1996 and 1997) and to station 1110.



Figure 6. Dendrogram stemming from the Cluster Analysis applied to Table 11.

Future Work

All the available information about the environmental background in the Hanstholm area will be used to provide a sensitivity map of the area that could be used to predict the impact of the future human activities in the area. This knowledge could also be used as reference baseline in future studies aimed to assess the environmental impact of wave energy installations using a BACI (i.e. Before and After Control Impact) design approach.

If dedicated funds would be available the Hanstholm test site could be used as a pilot area to to study environmental impacts and interactions with marine organisms, ranging from small bottom dwelling organisms living in the seabed, organisms involved in biofouling (and therefore of interest to mechanical wear and maintenance) to vertebrates, including fish, seabirds and marine mammals.

Concerning the sea bottom fauna, sediment cores could be collected on seasonal basis in the sites chosen for deploying WEC devices allowing a site-specific quantitative analysis of the macrofauna to assess the percent gain of hard bottom habitat offered by WEC foundations or mooring devices.

Dedicated monitoring campaigns could be designed to assess fish, seabirds and marine mammals abundances in the area.

All the future sampling campaigns should be designed using a BACI approach (e.g. before and after the pilot WEC deployment).

An additional element for the impact assessment would be, after the deployment of WEC devices needing antifouling treatments, the use of biomarker organisms (e.g. Noventa and Pavoni, 2011) to evaluate the contamination due to the antifouling compounds. This analysis would require the collection of additional data for at least a couple of years after WEC deployment and budget for the needed chemical analysis.

Conclusions

This report presents a preliminary assessment of the environmental background of the DanWEC site and is part of the task 4: "Collection and presentation of basic data on flora and fauna for the DanWEC site at the Port of Hanstholm" of the project No. 834101 "DanWEC Vaekstforum 2011". The available data on the bethonic community collected in the area of the Port of Hanstholm have been analysed. No seasonality effect has been assessed in the available biomass data series whereas a bathymetry effect was detected (i.e. the deepest station has a lower biomass value).

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