COASTAL PROTECTION
AND
BEACH CONSERVATION
GHANA

ACCRA BEACH

Christiansborg built by Danes 1621

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Evaluation of Coastal Engineering Test
Accra Beach - Ghana

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FIELD TEST ACCRA BEACH GHANA

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Abstract
Land-based activities and natural physical processes have resulted in significant modifications of the shorelines in many countries, with drastic effects on the coastal geomorphology as well as on the coastal infrastructures. There is an urgent need to introduce new and cost-effective measures that can reduce and mitigate the impacts on the shorelines.
SIC Skagen Innovation Centre has invented an environmentally friendly coastal protection system. The SIC system is based on pressure equalisation modules and fascines. A long-term and comprehensive test of the efficiency has been carried out on the West Coast of Denmark. Furthermore, a twelve-month scientific research programme was performed in 1999. The results obtained show that the system is far more efficient than conventional methods such as groynes, breakwaters and sand nourishment. Due to the well-known lee side erosion effect, groynes and breakwaters create even greater erosion in adjacent coastal areas. Sand nourishment by dredging is in general terms a very expensive approach (about 130,000 USD / km / year in Denmark), but unfortunately it is an inefficient solution since usually the sand will disappear during the first spring tide.

Summary
With background in the above SIC established in July 2000 in cooperation with ABC Hansen A/S and NDA Construct an environmental friendly pressure equalisation plant in Ghana. The plant was established on a 1,000 m stretch on Accra Beach west of Independence Square.

The purpose was to explain the possibility to achieve positive results under very different conditions than tried before.

The test is very successful indeed. The final result from the measurements carried out during the period shows an increase of 17.76 m^3 per running metre of new sand on the coastline. Compared to the successful plant in Old Skagen, monitored by Carl Bro, Denmark, where the increase is 6.5 m^3 per running metre, the plant in Ghana is without any doubt the most successful plant installed so far.

The test area at Accra Beach is considered rather difficult with four freshwater outflows mainly rainwater and sewage from the hinterland. This combined with lee side erosion from the Accra harbour mole causes heavy erosion on the beach.

During the test period we experienced a very heavy storm in October 2000 which caused severe erosion and lowered the coastal profile by up to 1.10 m.

We find the final result very satisfactory, as a new and wide beach is now visible as can be seen from the following pictures from Accra Beach. The pictures before and after are not technically photographic directly comparative but show the development on the beach and documented with levelling carried out before and after.

The measurements from the engineering company Rudan/Carl Bro are attached as enclosure 19 and 20.

Christiansborg Accra 1999

Christiansborg Accra 1 year later

Photo Accra Beach Jan. 2001 direction east

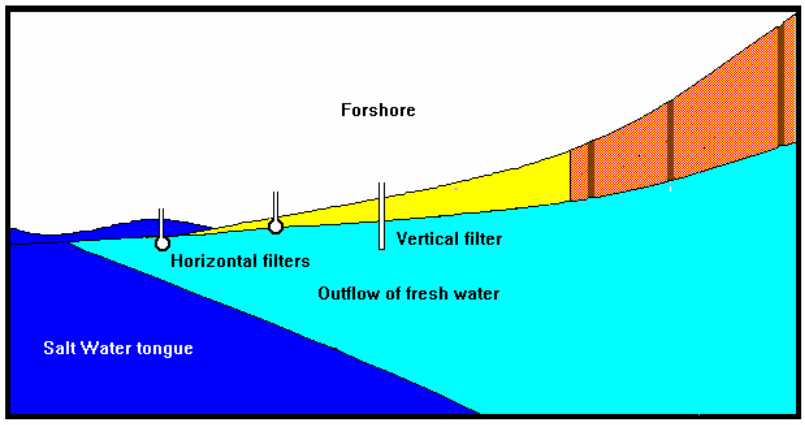
Photo Accra Beach Jan. 2001 direction west

INTRODUCTION

The SIC system is radically different to the dredging, sand nourishment and groynes building methods hitherto being employed. The SIC System makes the lowest impact on the aesthetic beauty of the beach area without disfiguring it with boulders etc. It also precludes sand nourishment activities since it basically traps the sediment transported by the sea on to the beach and thus starts the beach rehabilitation process by extending the beach further into the sea. The basic principle of the SIC system is pressure equalisation of the hydrodynamic forces along the coastal stretch it is being implemented on.

Pressure equalisation modules build up a wide balanced coastal profile. This has the significant advantage of causing the waves to loose their destructive energy while running uphill during high tide situations. Thus, the erosion of the coast profile is mitigated even in spring tide situations compounded by effects of hurricanes.

During the tests as carried out in Skagen it was recognised that the groundwater table was 2 metres above the sea level in a distance of only 70 metres from the coastline. Due to the gravity there is a considerable groundwater pressure from the land side. Thus, it can be illustrated that the sea water in the swash zone percolates through the sand and runs back into the sea "on top" of the groundwater discharge area. This promotes the erosion process compounded with the back run of the sea water in the swash zone.



Equilibrium Profile

As a result of SIC's research and experiments over the last 6 years, we now experience wide equilibrium coastal profiles at locations where SIC has installed pressure equalisation modules. At the same time the local people tell us that they have never seen wider sand beaches.

Theory

Pressure equalisation modules are vertical filters that are placed in a matrix along the coastline. The filters equalise the pressure of the ground water basin and an increased circulation of seawater in the coastal profile will take place. This will promote sedimentation of materials on the coastal profile.

During our work we have developed the following theory (in short): The pressure equalisation modules increase the drop of the water level in the coastal profile in the period from high tide to low tide. Thus, the beach will be more effectively drained of water. When the water level is low on the coast during the period from low tide to high tide, the water circulation in the swash zone increases, which again increases the depositing of materials on the foreshore, thereby building up the beach from the sediments transported along the coast. Over time the new materials in the coastal profile are increasingly coarse, due to a higher speed of the underlying water in the coast profile. The result of deploying the pressure equalisation modules inside a coast profile, is a strong and very wide equilibrium profile. To build up the dunes on the beach, fascines are used to collect the sand blown along the beach by the wind.

MONITORED FIELD RESEARCH

On this background it was agreed with The Ministry for Works and Housing to carry out a field research on Accra Beach. This is shown on drawing No. TL101 and the aerial photo from the Accra Beach.

The plant was installed using pressure equalisation modules build from galvanized steel pipes, 1.5 m in lengths. The pipes are fitted with 0.5 m or 1.0 m special filter.

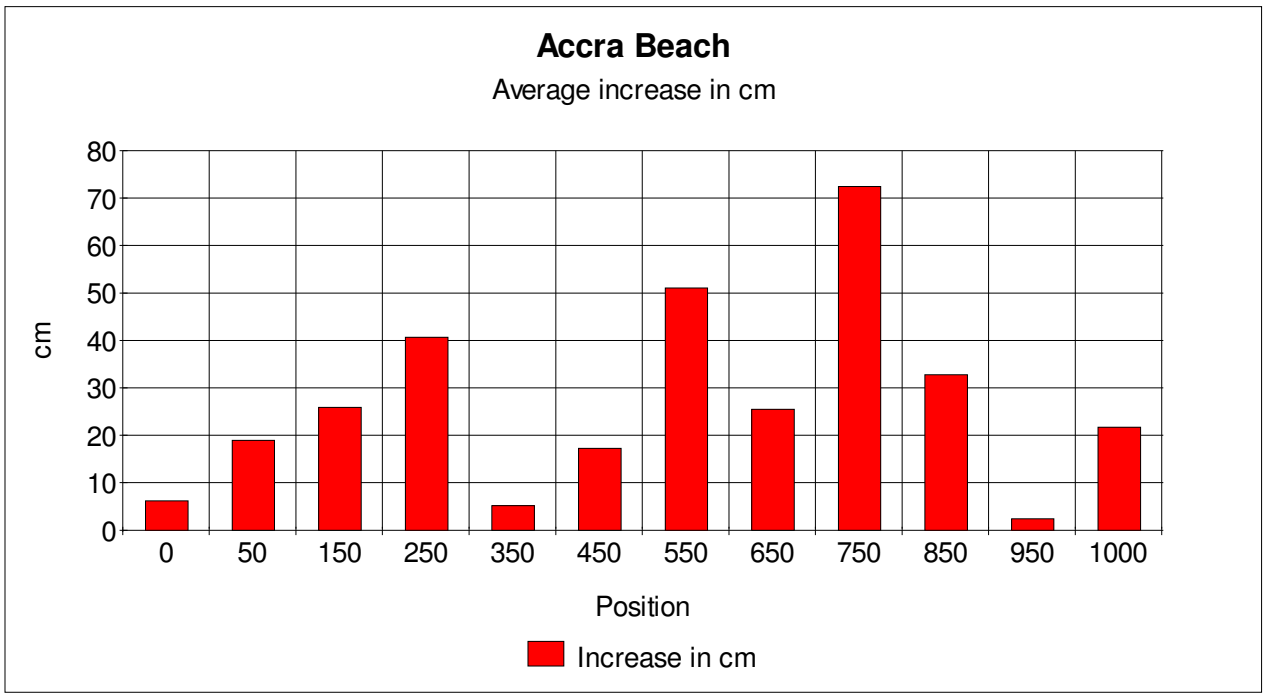
The modules are closed at both ends by ventilated screwcaps.

The modules were initially installed at the beach with only 40-60 cm above the sand.

As can be seen on the drawings the modules are placed in a matrix with 50 or 100 metres between the rows along the beach and 10 metres between the pipes in the cross-section.

The plant was installed July 14, 2000 and the only equipment used was a JCB digger on crawler tracks.

Survey

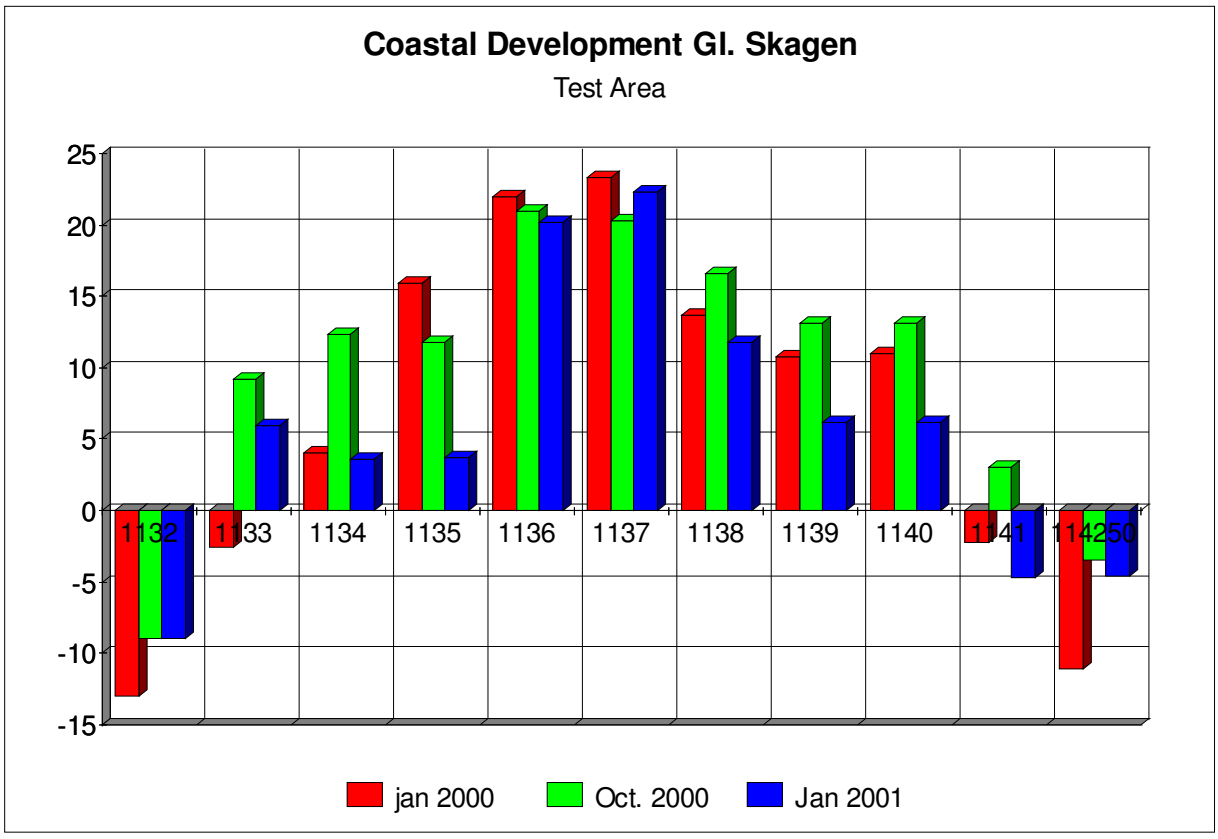


The coastline was measured July 18, 2000 by Rudan in cooperation with Carl Bro. It is important that an impartial control body carried out the measurement.

It was decided that the test period was to be six months, and the coast profile was measured again January 19, 2001 with the abovementioned result. It is also important to mention that during the six months test period, an engineer employed by SIC/ABC HANSEN A/S measured all modules every day.

The average raise in the profile on the 66,600 m^2 was 26.66 cm, which shows an increase of 17.76 m^3 per running metre along the pressure equalised coastal profile on Accra Beach.

Old Skagen - Denmark



For comparison reasons it can be mentioned that the increase in the monitored research project south west of Old Skagen is 5.6 to 6.5 m^3 per running metre.

The coastal profile is, however, only 35.33 m wide in average in contrast to the profile on Accra Beach with 66.66 m in average in the measured area. The plant south west of Old Skagen has been in permanent use for more than two years, and the profile is now stable.

Conclusion
After a test period of six months with a very heavy storm in October 2000, a very significant and positive development in the coastal profile is seen and similar to other plants installed at other locations.

The wind directions on the coast of Ghana are generally south west. Only in January 1992 and 1993 the wind direction turned to north west for a short period. The wind direction has no special influence on the build-up of the beach.

The average increase (supply of new sand) is measured to 17.76 m^3 per running metre and the raise in the coastal profile is measured to 26.66 cm in average.

Of all the plants installed, the plant in Ghana is showing the most positive result. The result is very satisfying, and on this basis we intend to continue our activities in Ghana within the field of coastal protection using the SIC pressure equalisation modules.

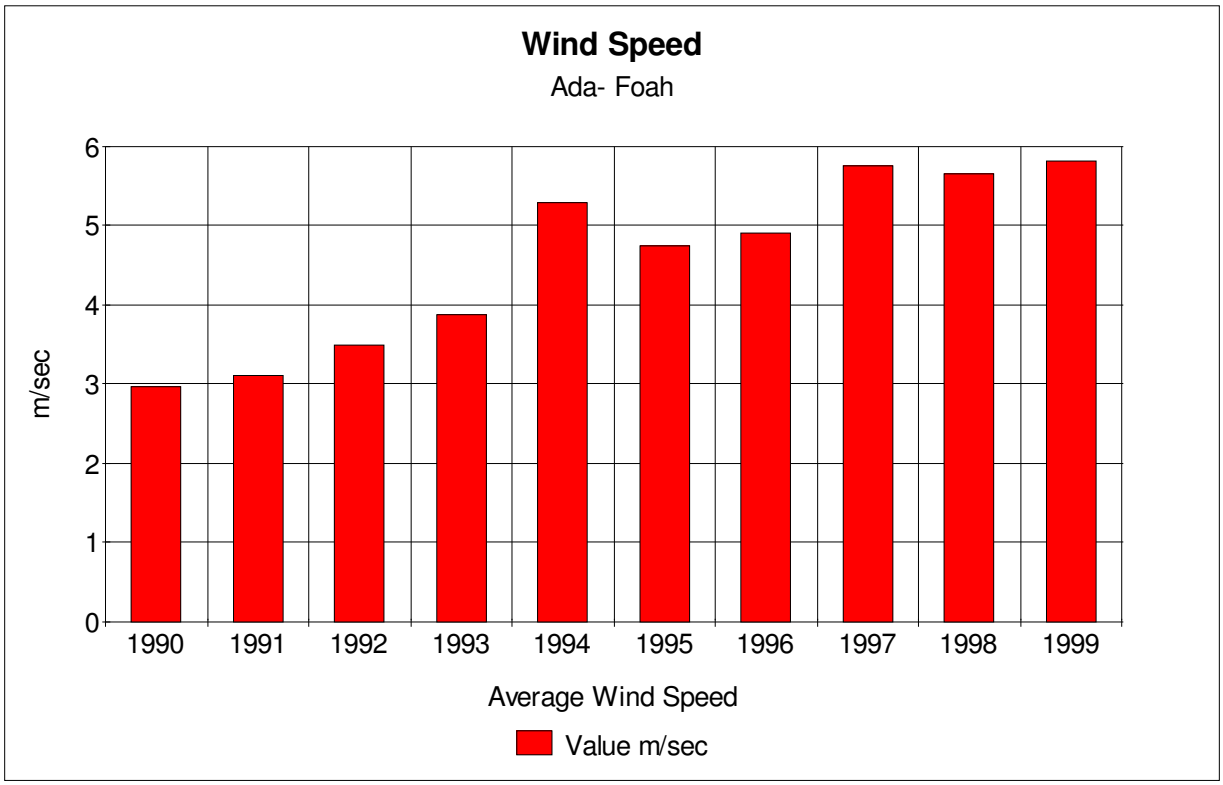
Weather

	jan.	feb.	mar.	apr.	maj.	jun.	july.	aug.	sep.	oct.	nov.	dec.
1990	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1991	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1992	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1993	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1994	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1995	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1996	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1997	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1998	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
1999	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW

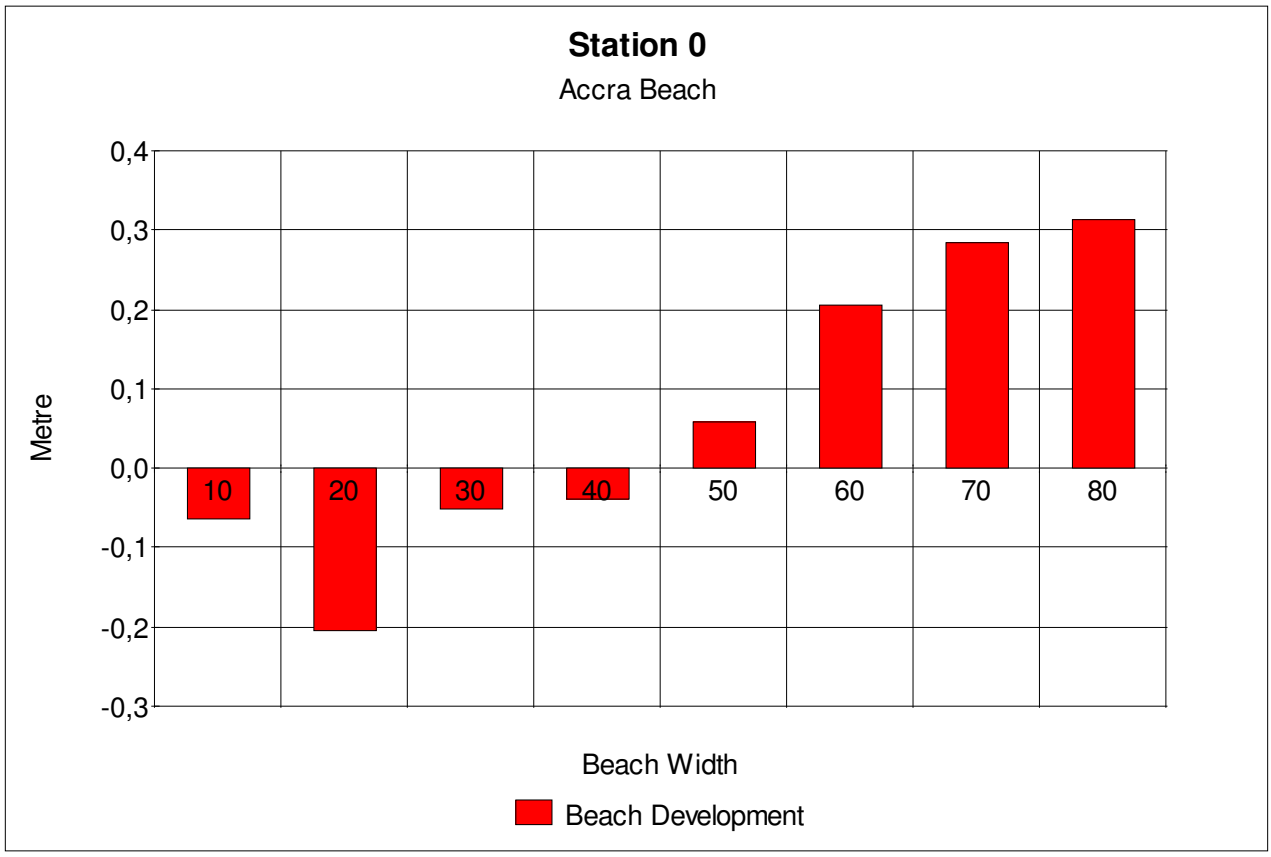
Wind direction

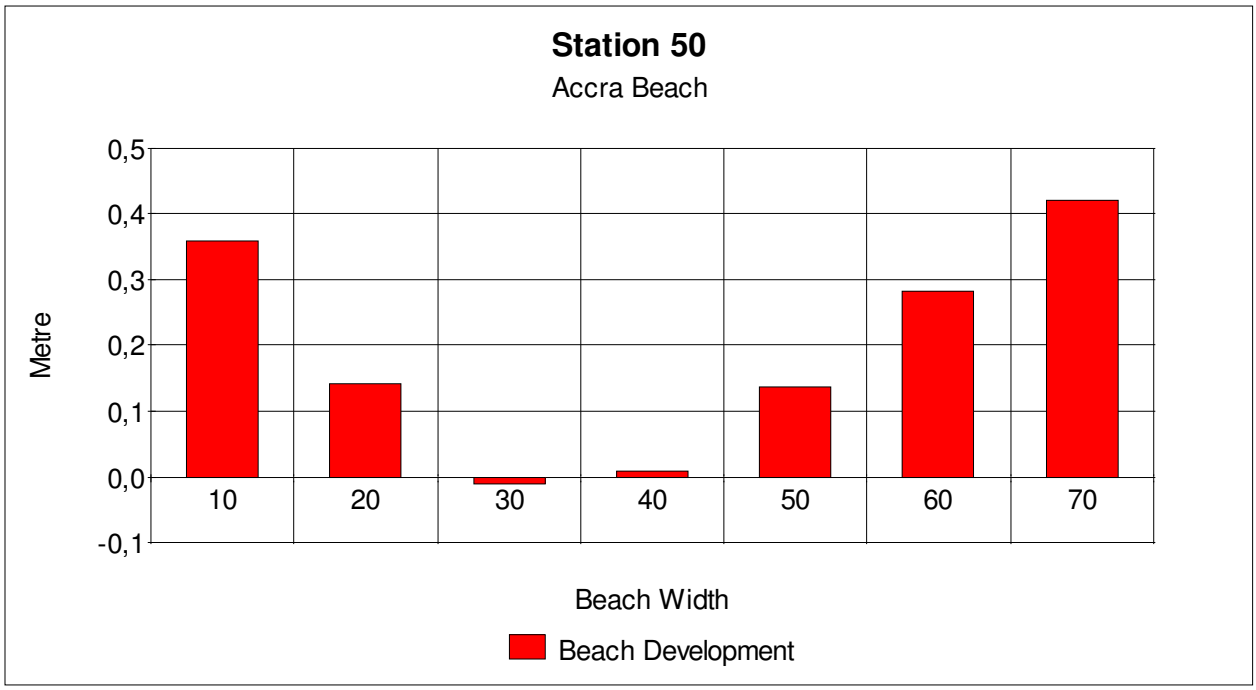
	jan.	feb.	mar.	apr.	maj.	jun.	july.	aug.	sep.	oct.	nov.	dec.	Averag
1990	2,6	3,4	3,3	3,7	2,8	3	4,2	2,8	2,6	2,6	2,3	2,4	2,98
1991	3	4,4	3,6	3	2,5	2,4	3,6	2,6	3,3	3,5	2,6	2,8	3,11
1992	3,5	2,7	3,3	2,6	2,6	3,7	3,9	4,1	4,8	4,5	2,8	3,4	3,49
1993	3,3	4,5	4	4	3,7	3,4	3,8	4,4	4	3,7	3,7	4	3,88
1994	5,2	7	6	5,6	5,4	4,5	3,1	4,5	6,2	5,9	4,7	5,4	5,29
1995	4,8	6,8	5,4	5,8	5	4,3	3,4	4,1	4,4	5,2	3,9	3,8	4,74
1996	3,8	5,5	3,8	5,1	4	3,1	4,9	4,6	5,8	6,8	5,8	5,6	4,9
1997	4,9	5,4	5,7	5,6	4,5	5,5	5,9	6,4	7,2	5,8	6,5	5,7	5,76
1998	4,3	5,4	5,3	5,3	4,7	5	5,7	6,5	7,1	6,9	6,1	5,5	5,65
1999	6	6,4	7,3	6,7	5,5	4,2	4,7	5,5	6,1	7,4	5,3	4,6	5,81
	4,14	5,15	4,77	4,74	4,07	3,91	4,32	4,55	5,15	5,23	4,37	4,32	4,56

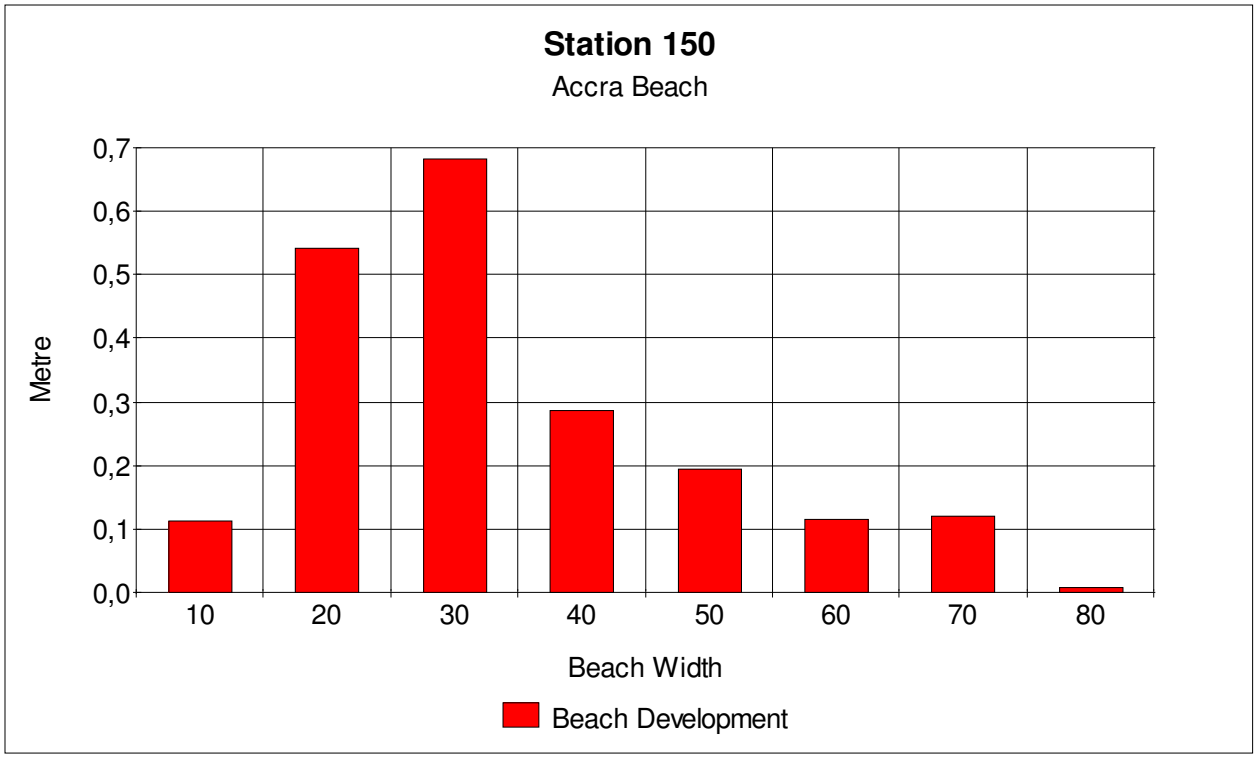
Wind speed over 10 years

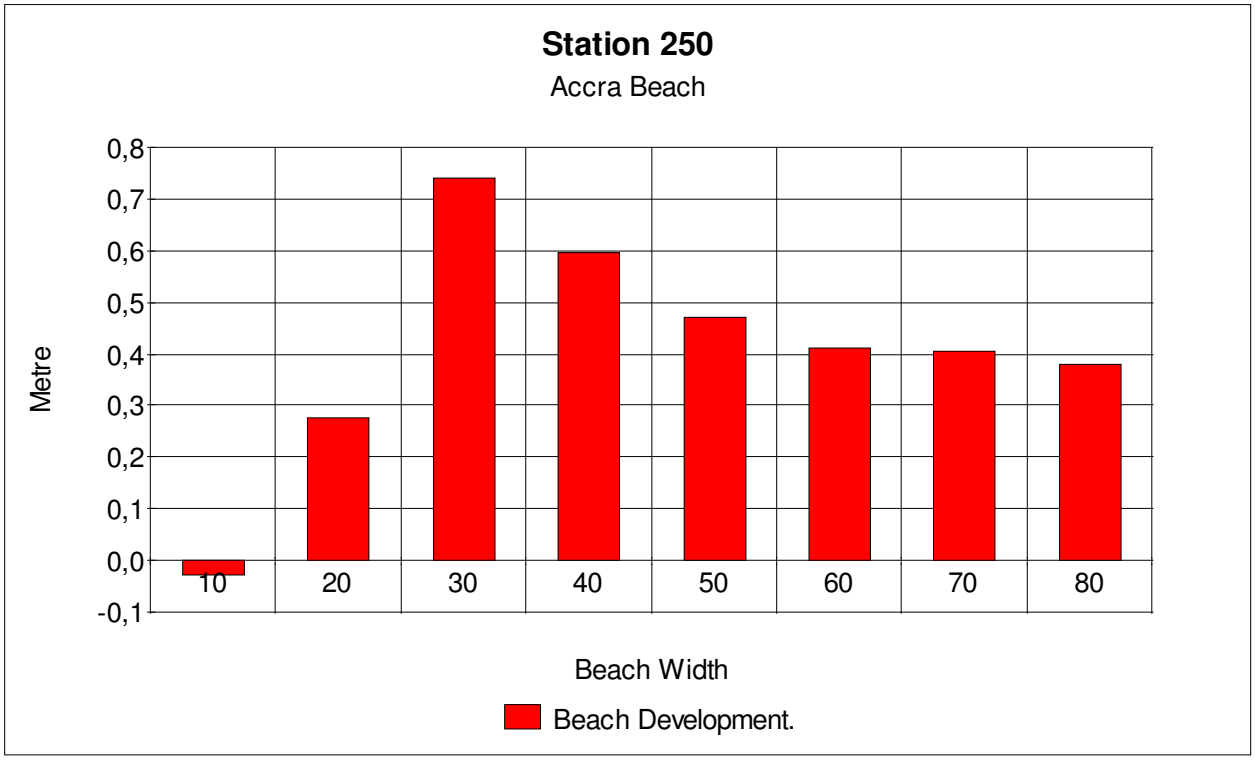


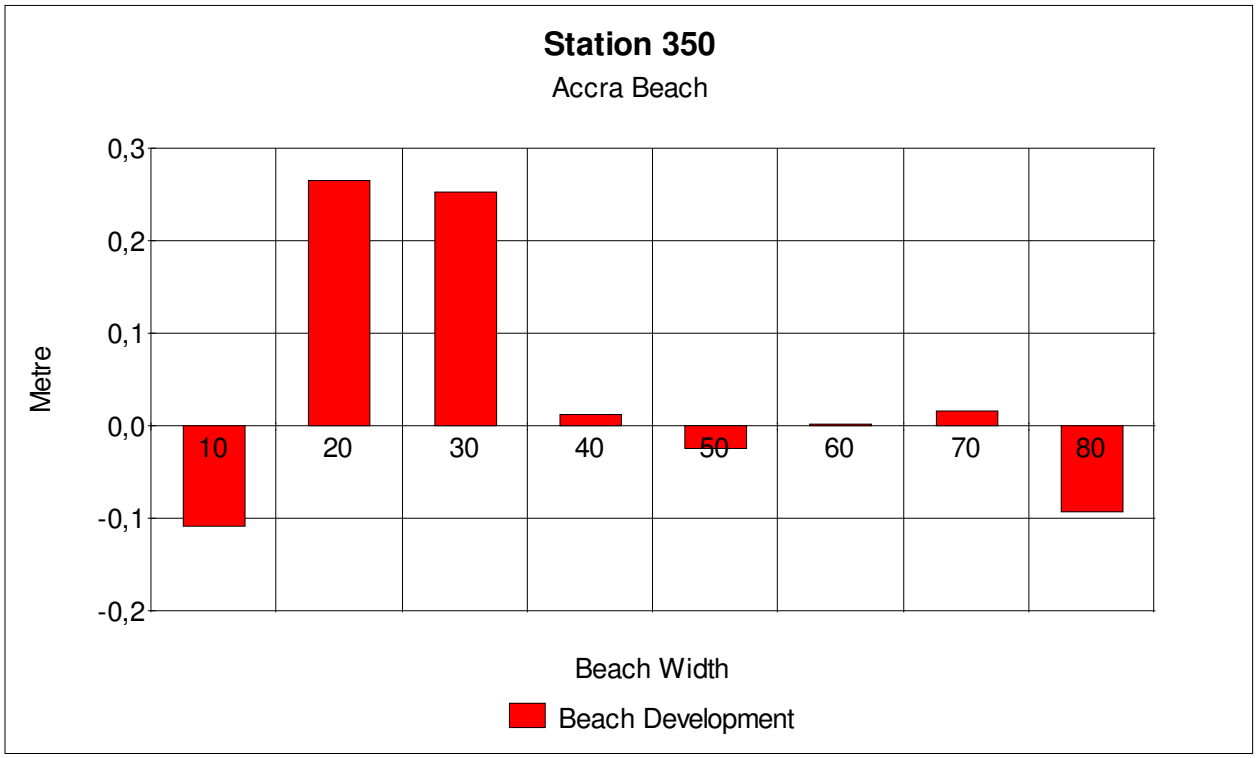
The measurements show that the wind speed has doubled over a period of 10 years, but need to be reconfirmed.

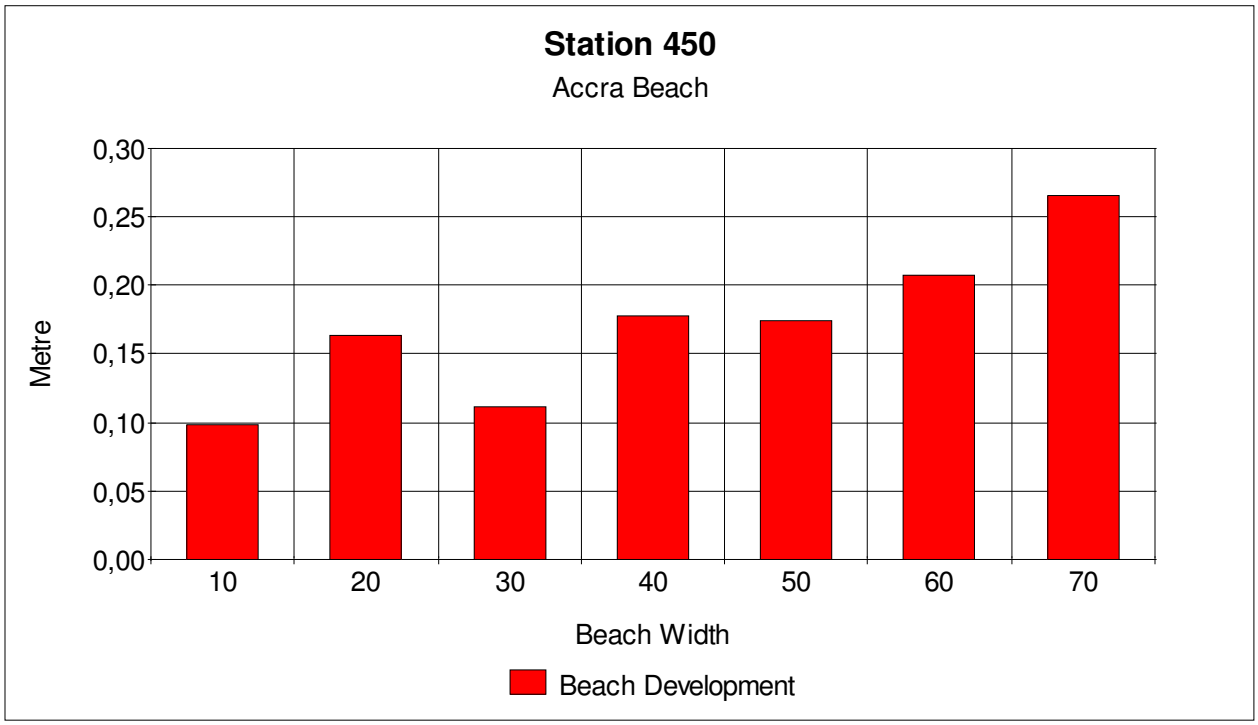

Station 0
Accra Beach
0,4
0,3
0,2
0,1
0,0
-0,1
-0,2
-0,3
Metre
10
20
30
40
50
60
70
80
Beach Width
Beach Development

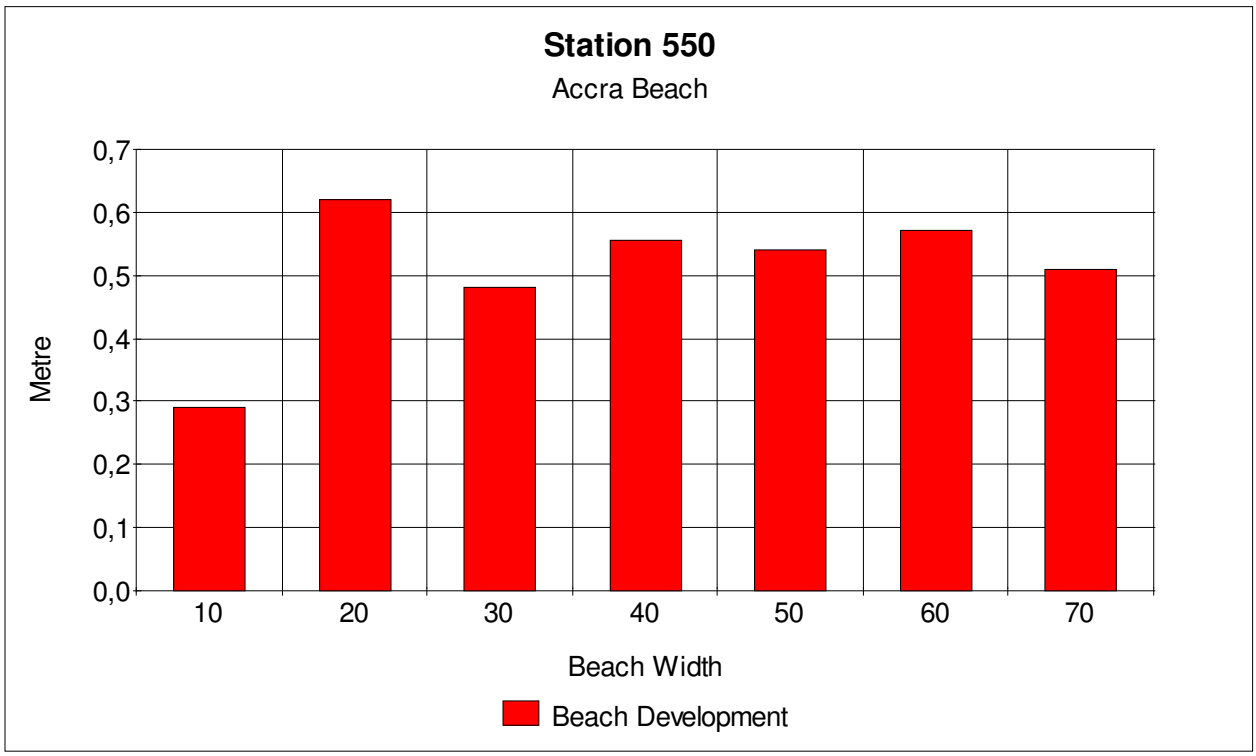

Station 50
Accra Beach
0,5
0,4
0,3
0,2
0,1
0,0
-0,1
Metre
10
20
30
40
50
60
70
Beach Width
Beach Development

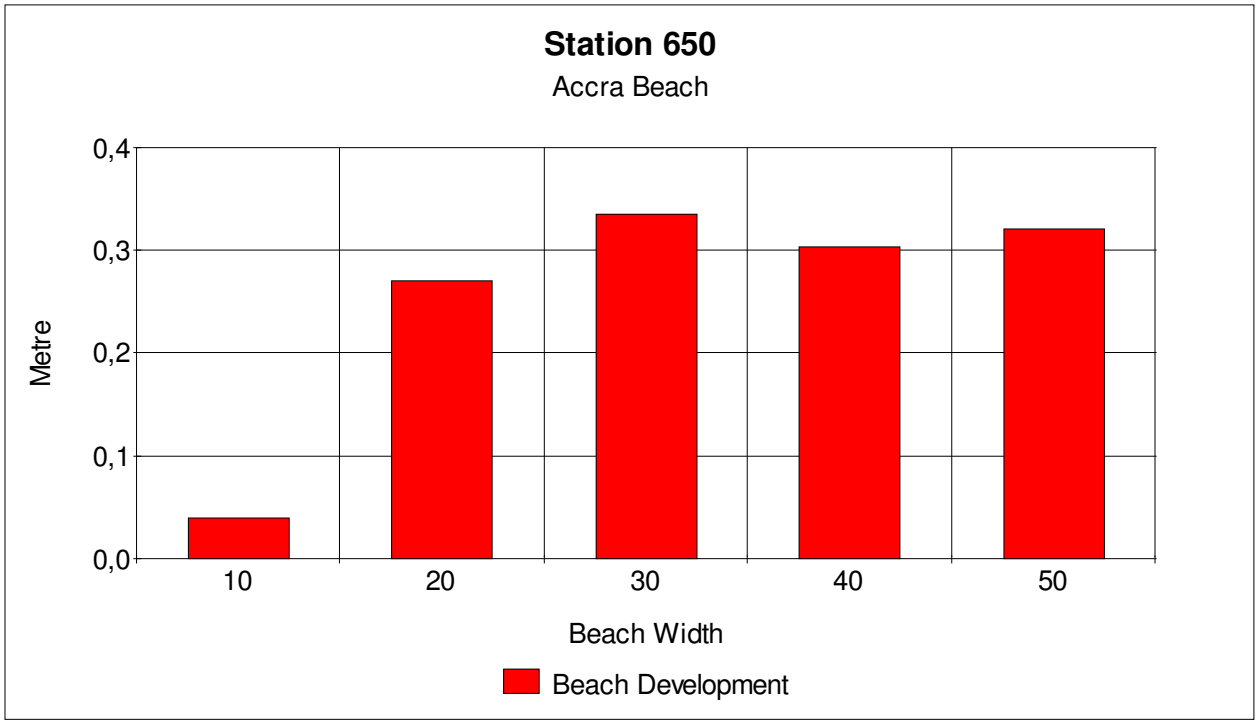

Station 150
Accra Beach
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
Metre
10
20
30
40
50
60
70
80
Beach Width
Beach Development


Station 250
Accra Beach
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
-0,1
Metre
10
20
30
40
50
60
70
80
Beach Width
Beach Development.


Station 350
Accra Beach
0,3
0,2
0,1
0,0
-0,1
-0,2
Metre
10
20
30
40
50
60
70
80
Beach Width
Beach Development


Station 450
Accra Beach
0,30
0,25
0,20
0,15
0,10
0,05
0,00
Metre
10
20
30
40
50
60
70
Beach Width
Beach Development


Station 550
Accra Beach
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
Metre
10
20
30
40
50
60
70
Beach Width
Beach Development


Station 650
Accra Beach
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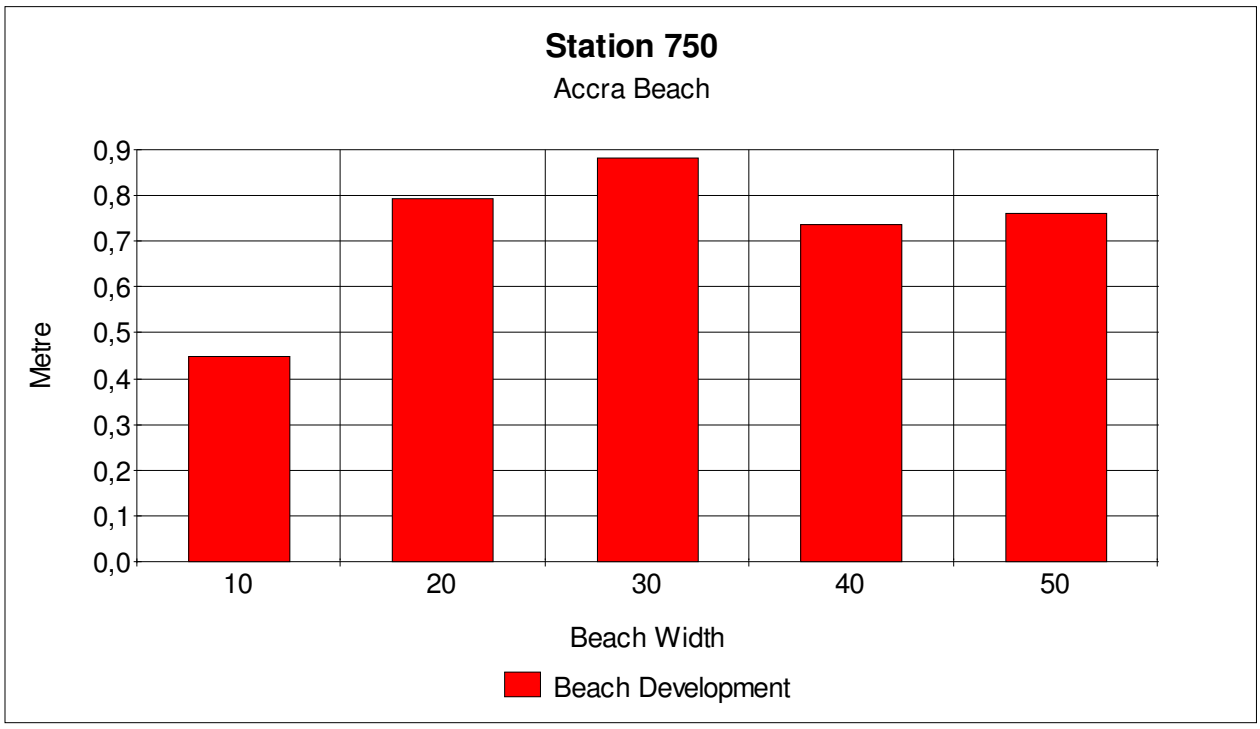
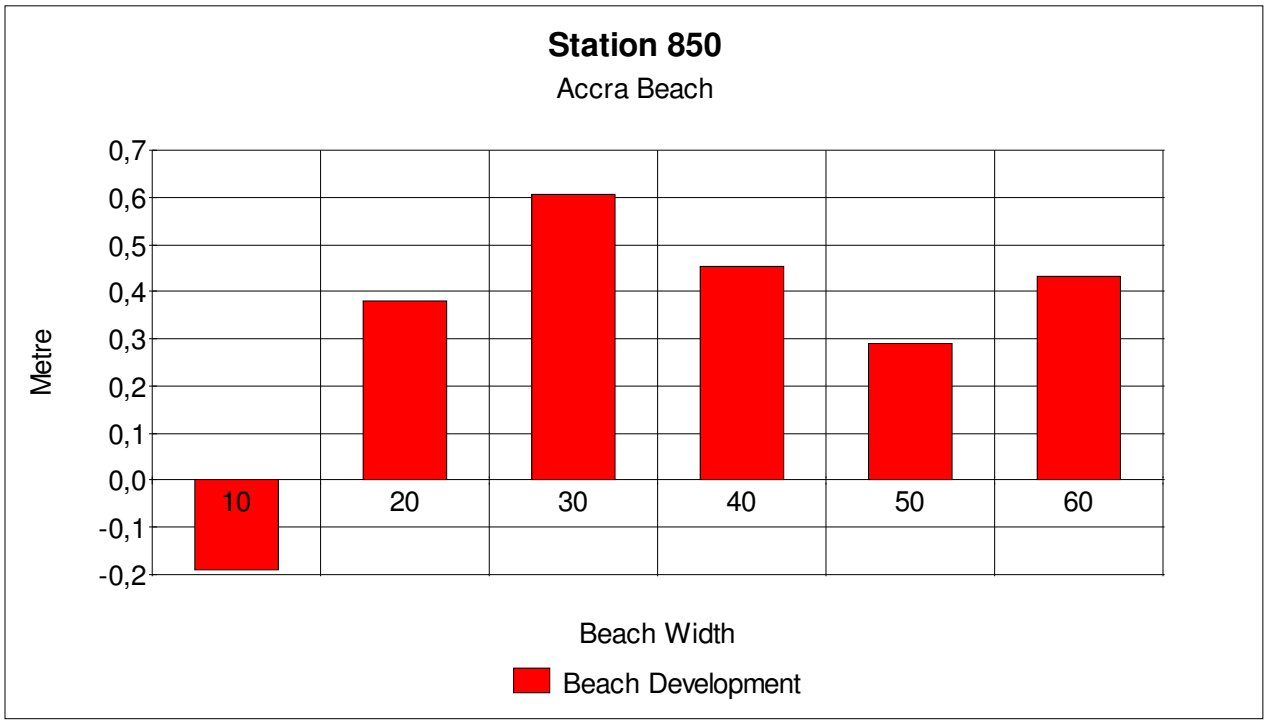
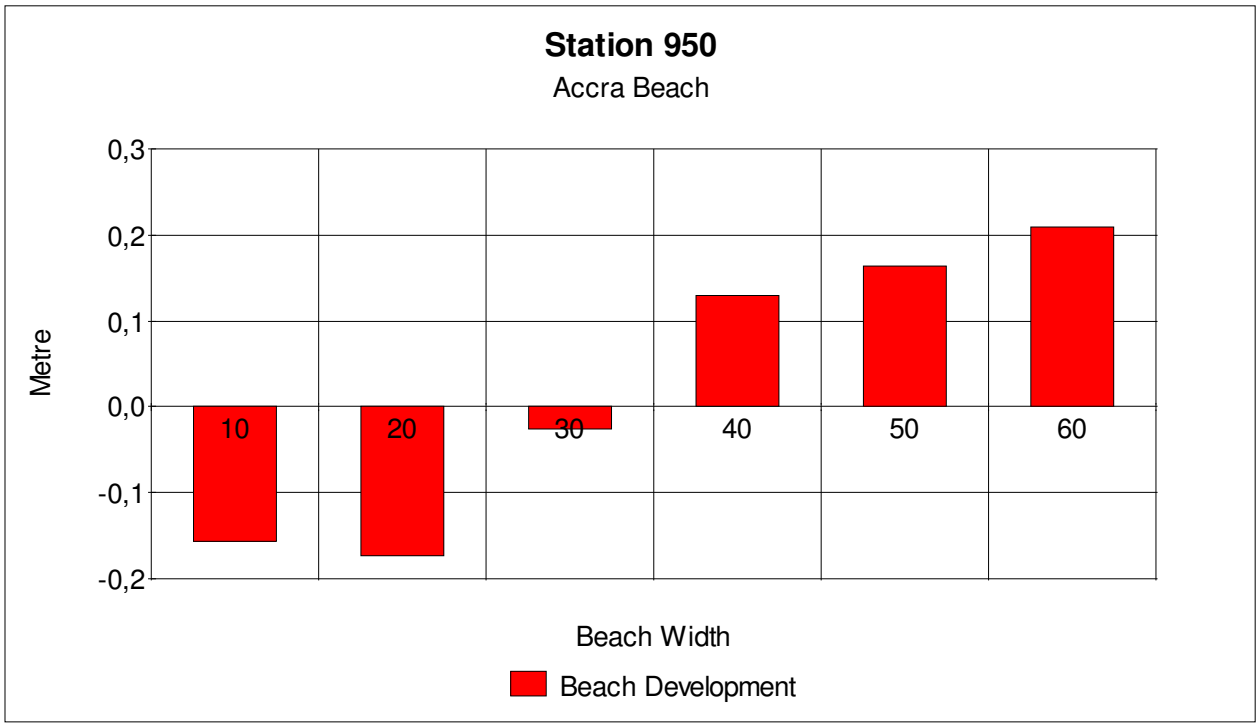
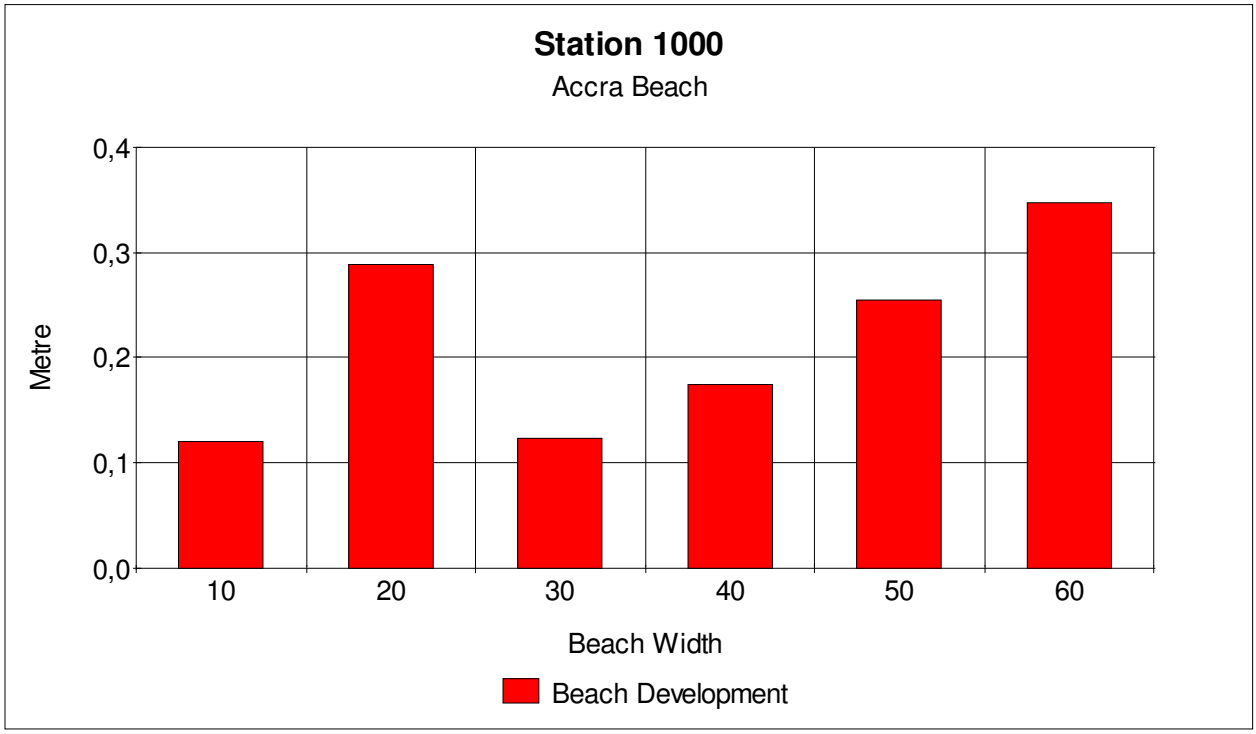
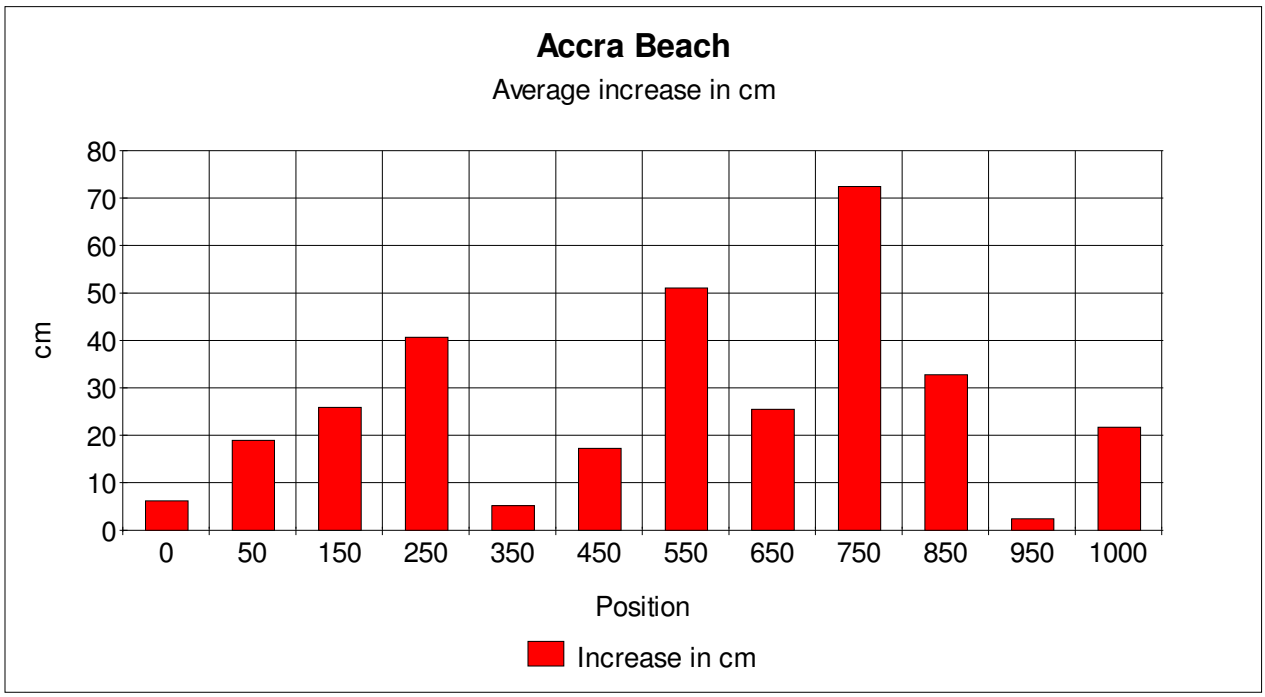
0,3
0,2
0,1
0,0
Metre
10
20
30
40
50
Beach Width
Beach Development


Station 750
Accra Beach
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
Metre
10
20
30
40
50
Beach Width
Beach Development


Station 850
Accra Beach
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
-0,1
-0,2
Metre
10
20
30
40
50
60
Beach Width
Beach Development


Station 950
Accra Beach
0,3
0,2
0,1
0,0
-0,1
-0,2
Metre
10
20
30
40
50
60
Beach Width
Beach Development


Station 1000
Accra Beach
0,4
0,3
0,2
0,1
0,0
Metre
10
20
30
40
50
60
Beach Width
Beach Development



Calculation of profile development Accra Beach
July 2000 - jan 2001

	Average	Profile	Profile		
Station	increase	Width m.	Length m.		
0	6,2	80			
50	19,1	70			
150	25,7	80			
250	40,6	80			
350	5,3	80			
450	17,1	70			
550	51	60			
650	25,4	50			
750	72,4	50			
850	32,9	60			
950	2,5	60			
1000	21,8	60			
Total	320	800			
Average	26,666667	66,66	1000	17776	Cubic metre.
Increase 17,78 Cubic meter pr. meter.					

Test Area Accra Beach
1000 meter

Enclosure
Drawing number TL 101 survey july 2000.
Drawing number TL 102 survey jan 2001.