

newsline

T H I S C H A N G E S

E V E R Y T H I N G

How computer science is changing science and engineering*



***Computing & Research** Special Report

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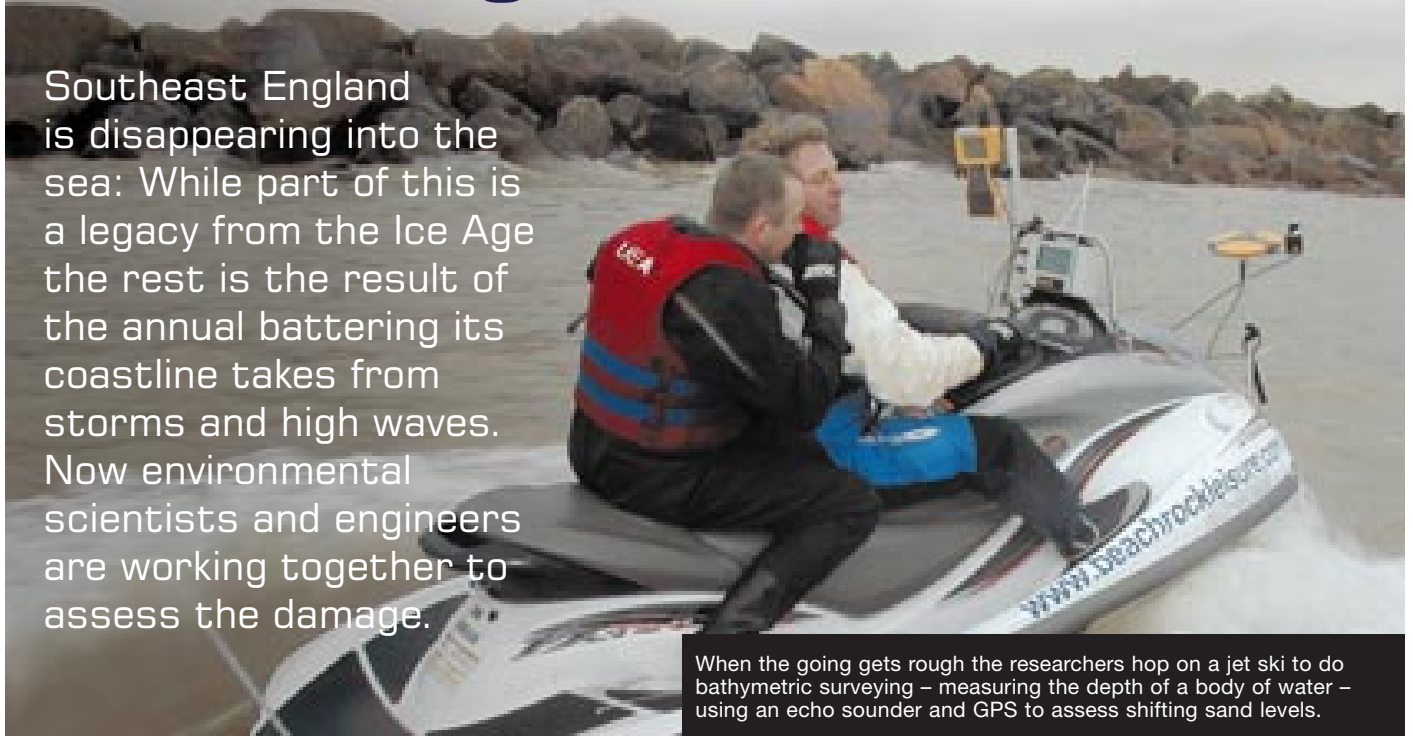
Quakes: Computing for earthquake science

Working on instinct
Robots model how we choose

Russian doll
Making molecular capsules

Breaking the Waves

Southeast England is disappearing into the sea: While part of this is a legacy from the Ice Age the rest is the result of the annual battering its coastline takes from storms and high waves. Now environmental scientists and engineers are working together to assess the damage.



When the going gets rough the researchers hop on a jet ski to do bathymetric surveying – measuring the depth of a body of water – using an echo sounder and GPS to assess shifting sand levels.

Living on the coast may bring fantastic views and fresh sea air, but there can be a downside when the sea decides to intrude upon your home. Every winter hundreds of British homes are at risk of being flooded each time a storm hits our shores. The southeast of the UK is particularly exposed because the land here is sinking at a rate of around 1mm per year (due to ancient glacial rebound making the land spring upwards in the north-west). Combining this with the expected changes from global warming (a rise in sea-level and an increase in stormy weather) and the prospects for the southeast do not look good.

To address this problem researchers at the Universities of East Anglia and Liverpool have been collaborating on an EPSRC-funded project to study the effectiveness of structures (such as breakwaters) at protecting the coastline from storms. LEACOAST (Liverpool-East Anglia COASTal study) has been investigating the impact of the large breakwaters that lie just offshore along the East Anglian coast, near the village of Sea Palling in North Norfolk. In 1953 Sea Palling suffered a very large winter storm. Seven people were drowned when the waves crashed over the sand dune that separated the land from the sea and many houses and fields were damaged by the ensuing floods. After this tragic event a concrete sea wall was built to provide extra protection for the community but by 1994 the sea wall had started to show signs of serious damage and urgent action was needed. The Environment Agency quickly constructed a series of breakwaters (piles of rocks just off the coast) to try and lessen the impact of the waves.

All along this stretch of coast Scandinavian rock rubble was arranged to guard the land against attack from the sea. These breakwaters form a broken line about 250m out at sea.

Each breakwater is around 250m long with a 250m gap to the next breakwater. Nowadays Sea Palling's population is about ten times greater than in 1953 and a flood like the 1953 one would be disastrous. So how effective are the breakwaters and are the people of Sea Palling safe from winter storms?

Jet ski science

For the last two winters Professor Chris Vincent and his team, from the University of East Anglia, have been on standby to rush out and take measurements before and after every storm. "We wanted to observe how much sand was moved around by each storm and where the most vulnerable places were," he explains. Every time that a storm was forecast they followed its development and made a dash for the beach if it looked like it was going to hit Sea Palling. They measured and recorded the shape of the beach by zipping up and down on quad bikes, building up a 3D picture of the beach using a global positioning system (GPS). Out at sea things got slightly trickier and they employed jet skis with echo sounders on the bottom of the skis. The time taken for the sound to bounce off the sea-bed told them how deep the water was, while the GPS recorded their location. Putting this information together enabled them to map the beach and sea floor right out to where the breakwaters were.

Immediately after the storm had passed they raced back to the beach and repeated the measuring process all over again, to see how much the storm had managed to dent the beach. Each winter there were around sixteen storms, meaning around thirty-two trips to the beach and some rather unpleasant weather to boot. "We had to time our trips to coincide with low tide and as much daylight as possible," says Professor Vincent. Back in the warmth of their offices they



The breakwaters built to protect the areas around the Sea Palling site from storm damage viewed from the air. Understanding how effective these are will help coastal engineers to improve flood defences.

analysed their findings. “We saw that each storm moved large quantities of sand around. The most vulnerable places were the gaps between the breakwaters, where large embayments were carved out,” Professor Vincent explains. During normal conditions they found that moderate sized waves carried sand in and dumped it, helping to build the beach up. But when a storm arrived the large waves managed to slip through the spaces between the breakwaters and crash onto the beach, sucking up the sand and pulling it back out to sea. “The biggest storms caused a two to three metre drop in the sand level on the beach and re-exposed the original battered sea-wall,” he tells us.

However, it wasn’t all bad news. After the storm the beach recovered incredibly quickly, repairing around half of the damage within 48 hours. “Originally we were very worried about the cumulative effects of one storm occurring soon after another, but our

“We have a really good synergy between the field based scientists at East Anglia and the computer modellers at Liverpool.”

Professor Chris Vincent

observations demonstrate rapid beach recovery and mean that this is now less of a concern,” says Professor Vincent. Having measured the damage from the winter storms of 2002 and 2003, the scientists also wanted to predict the damage that future storms might cause. Working together with Professor Brian O’Connor and Dr Shunqi Pan, both from the Department of Civil Engineering at Liverpool University, they have created a computer model of how winter storms are likely to affect the East Anglian coastline. “We have a really good synergy between the field based scientists at East Anglia and the computer modellers at Liverpool,” explains Professor Vincent. So far they have managed to validate their computer model using the real data and they are now working on building a predictive model.

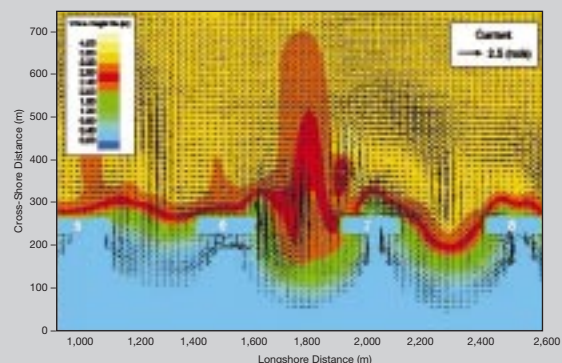
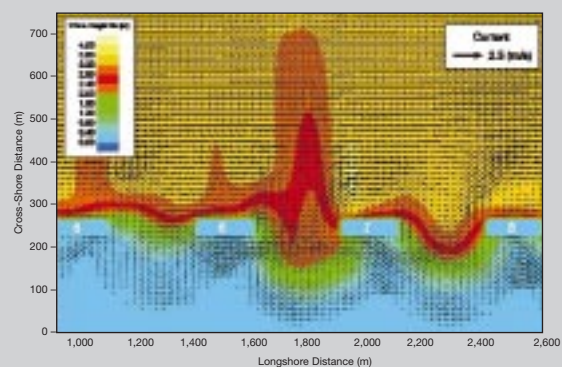
Hungry beaches

As well as considering the local effects of the Sea Palling breakwaters, the LEACOAST team have also been looking at the regional effects. One of the major worries is that these large breakwaters block sand movement and starve beaches further down the coast. “Currently the Environment Agency has to artificially ‘feed’ beaches near Great Yarmouth as a result of sand starvation from the action of the breakwaters near Sea Palling,” explains Professor Vincent. Dredgers have to go to a ‘borrow’ area out at sea and pump a sand-slurry back onto the beach. This is a very expensive

Tide Modelling

Researchers at UEA are passing on their measurements of sea conditions to computer modellers at the University of Liverpool in order to create accurate models of the effects of storms.

The top image shows the velocity and wave height distributions at the Sea Palling site under storm conditions at high tide with the image below showing the conditions at low tide.



process and makes some people question whether the breakwaters near Sea Palling should really be there. “The breakwaters at Sea Palling are probably a bit over-engineered,” says Professor Vincent. Their work suggests that the sizing and spacing of the breakwaters is crucial in controlling how much sand is moved around. Because the breakwaters are so big at Sea Palling they manage to gather up significant amounts of sand that might normally have travelled further down the coast. Meanwhile, the large gaps between the breakwaters mean that storm waves still reach the beach and cause damage. Next the team are hoping to carry out a study into the effects of breakwater spacing and size.

Understanding how the breakwaters affect the sand movement is the first step towards remedying the sand starvation problem. Eventually the LEACOAST team hope that their project will result in guidelines for coastal engineers; advising them on how to build breakwaters in areas where there is lots of sand movement and large tidal ranges. For East Anglia this kind of work is vital to ensure that its unique coastline and broadland environment is protected in an environmentally sustainable way. ■

Contact:

For more information visit

<http://pcwww.liv.ac.uk/civilCRG/leacoast/index.htm>