

Succeeding Where Canute Failed.



Norfolk main coast road following a tidal surge.

A proposal to restore the sand dunes and their natural sea defences along the length of the Norfolk and Suffolk coasts.



A natural beach at Aberdovey, Wales. Here the dune system adequately protects the shoreline and maintains the sand balance. There are no licensed aggregate dredging sites within 100 miles.

The Issue.

History has it that the Norfolk and Suffolk coasts have been disappearing into the North Sea since time immemorial. There is much truth in this but from the 1800's to the 1950's accretion was in force and the dunes grew, with some six separate interspaced dune systems fronting the sea.

However in recent times, and certainly from the 1960s onwards, there has been erosion at work which has been relentless, and it has seemingly taken on a dynamic of its own. The result is that the last sand dunes, the natural sea defence for extensive stretches of this coastline, are today on the brink of being washed away and only one third of that last remaining dune now exists.

The more seaward dunes have long since gone. They have yielded to the erosive force of the sea and its waves, particularly during storms, and now in all too many places coastal villages and their buildings are almost directly in the front line – only a final line of dunes stand in the way and it is their turn, very soon, to bear the brunt of the next sustained period of storms.

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Can this reality be prevented ?

Is there a way to halt the continued loss of sand dunes and the vital sea defence which they provide? Can we collectively, at both local and national level, intervene and create a natural solution which both solves the problem and is environmentally sound ?

The answer is, yes.

This is the issue which this Campaign addresses.

This Publication sets out the solution.

Some parts of the Suffolk coast are protected by natural shingle sea defences, assisted by bulldozing into shoreline ridges. Other places in Norfolk and Suffolk, principally ports, are defended by artificial hard defences – concrete sea walls – which provide genuine protection but in practice they also stop the sand supply to downtime

beaches and cause the energy of the sea to down drift along the coast to erode adjacent soft natural sea defences.

Some countries, like the Netherlands, spend exceedingly large sums of money on sea defences. The Netherlands builds embankments to protect vast areas of recovered land which are below sea level, and maintains strict controls on offshore aggregate dredging to help minimise erosion of these defences. In contrast, the UK's expenditure on sea defences is very modest and the policy of shoreline management is one, particularly along areas of the Norfolk coast, of managed retreat – effectively, no action and allowing the sea to erode and flood.

The great danger in Norfolk is that behind the natural sand dune defences there is a great deal of prime agricultural land and prime wildlife sites, and communities which reside below mean sea level. Should the sea break through there will be a disaster, as there was in 1938 and 1953 when many lives and dwellings were lost, and with a great deal of agricultural land becoming salinated and thus lost from production for several years. The immediate cause of those historic events, which we need to heed today, is that surge tides overcame the sea defences which had not been renovated or updated.



Map of north-east Norfolk showing (in blue) a small part of the extensive low lying inland area to be lost to the sea should the defences be allowed to fail.

The solution advanced by this campaign involves the expenditure of money, but still in very modest terms compared to countries like the Netherlands. The solution proposed also focuses on regenerating natural sea defences, not constructing hard defences, thereby harnessing a natural rather than an artificial approach.

The solution offered here will not interfere with the pattern of sea defence in shingle areas, nor will it interfere with places already possessing hard sea defences in the form of concrete sea walls.

Rather, it focuses on those areas with beaches and their sand dune systems which are currently without a coherent government-led sea defence management plan, which are currently being offered only “managed retreat” as a policy, and yet which can and should be effectively defended.

The solution proposed here is proven in engineering terms. Of course it will need careful application to take account of site specific features, but its effectiveness is historically proven. It is also a solution that can be readily financed, as will be explained, and it is a solution that seeks to work in sympathy with natural forces rather than in opposition to them.

It is a solution which we believe everyone, whatever their perspective, will be able to support and recommend.



Erosion of beach and the natural sea defence system at Hemsby, Norfolk, following a tidal surge.

The Causes.

Reversing the causes is not the solution.

The hard fact is that the causes are on the one hand natural or semi-natural, and thus irreversible, and on the other hand are man-made and driven by economics and society's imperatives, and therefore ineradicable.

The natural and semi-natural causes are linked to climate change and fossil-fuel energy use over the last two centuries and this link will continue, most likely, for a substantial part of the present century and even beyond. Elevated levels of carbon dioxide and other greenhouse gases in the atmosphere have raised, and continue to raise, global temperatures with the result that sea levels are rising and the severity of storms is increasing. This creates a more powerful sea as it interacts with the coast, and sand dunes easily succumb to its erosive impact.

The man-made causes are linked to the extraction of sand and gravel from the sea bed offshore from the Norfolk and Suffolk coastline, a process which the licensed aggregate industry has been engaged in since the 1960s. This material, which has replaced land quarries, is now indispensable to the construction industry and the economy. Nearly all of London's new construction now relies on marine sourced aggregate, and other regions of the country display similar degrees of dependency.

Due to climate change, the sea's tides reach higher up the beaches and the waves are taller and have greater energy, and so cut ever more deeply and relentlessly into the sand dunes. At this time sea level rise is said to be 2.5-3.00 mm/year, but will accelerate sharply when the Greenland/Arctic and the Antarctic ice cover melts. East Anglia and Kent also experience geological sinkage of around 1mm/year. With a beach profile (gradient) of 1 in 10 in Norfolk, this results in an inland sea incursion of no more than $4 \times 10 = 40\text{mm}$ (4 cm) per year. Not a great amount really.

However at Hemsby, Norfolk, the incursion by the sea into the sand dunes has been over 100 metres since offshore aggregate dredging began in the 1960s. This is a mean annual average loss of around 2 metres, far higher than that predicted by sea level rise and geological sinkage alone. Consequently there must be an additional cause. This is why offshore aggregate dredging comes into the picture.

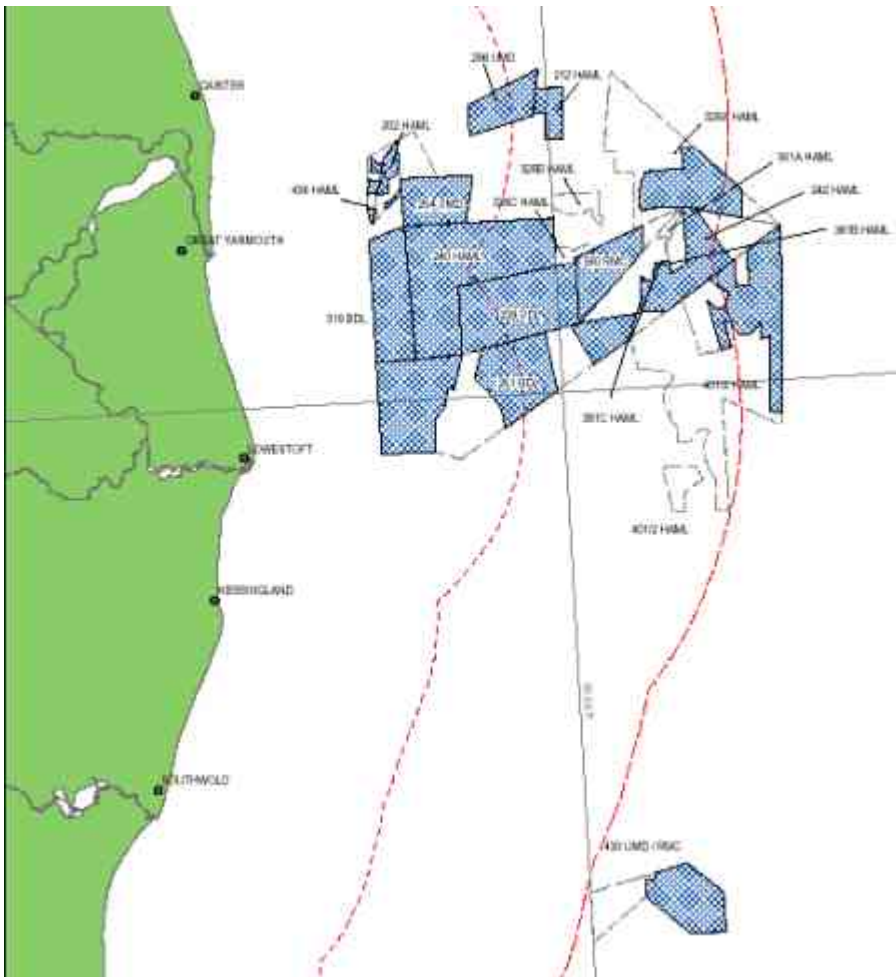
Due to aggregate dredging, the sand on the beaches is drawn down to the sea into a dynamic process that fills the offshore excavations, with the result that the profile and angle of the beaches are steepened. Steeper beaches mean higher waves closer to the shoreline and that the sand deposited there by the sea during calmer times in summer is very readily drawn back into the sea, with the additional effect that the

beach sand which used to be available to build and regenerate the sand dunes has disappeared. Consequently the sand dunes are relentlessly eroded and now, after a succession of decades, they are largely gone.

This crisis has been evolving for a long while. The sand dunes, built up in the past over a long period, have supplied the coastal inhabitants of Norfolk and Suffolk and its hinterland with a natural sea defence system, but now reality has changed.

From a historical perspective, the arrival of the modern world has set in train forces which are, although natural in appearance, driven by society's economic imperatives and, upon analysis, are revealed to be either irreversible or ineradicable.

As a result the sea, although the creator of this coastline and its sand dunes, is now its eraser. If we are honest, we are the author of these changed circumstances and the misfortune they bring. So can we do now what, metaphorically speaking, Canute never managed - hold back the sea?



Aggregate dredging sites off the East Anglian coast. Source : BMAPA and The Crown Estate. Their web sites www.bmapa.org and <https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/aggregates/> are where further information may be found.

The Solution.

The solution is groynes, built at an angle perpendicular to the coast and constructed at regularly spaced intervals roughly between high water and low water mark, along the whole length of the Norfolk and Suffolk coast where natural sand dune sea defences predominate.

They solve the problem because they both intercept the sand travelling naturally offshore along the coast - longshore drift – and they cause the sand suspended in the waves and brought ashore by the sea to be deposited on the beach thus rebuilding the depth of the beach, lowering its angle and profile, and once again affording a generous supply of sand to move landward from the beach to create sand dunes.

By this means, the natural sea defence is reborn and allowed to regenerate.

The material for these groynes is natural rock and boulders. This material will not decay, erode or be easily displaced, and over time as sand builds up the material will merge into the natural coastal landscape, its task fulfilled.

Other materials are available – tyres, timber and concrete. However all have significant side effects. Tyres are not easily held in place, and tyres today are now made in substantial part from synthetic rubber – plastic – which erodes and pollutes the sea. Timber rots and so needs to be regularly replaced, and durable marine timber comes from scarce forests which ought not to be felled. Concrete requires cement which requires large amounts of energy to manufacture it from limestone or chalk, and concrete also requires sand and gravel which is increasingly sourced from the seabed.

Natural rock and boulders are not without their environmental impact. They have to be quarried and transported. However they are a natural material, their durability is unequalled and their overall carbon footprint is no greater, possibly less, than that of the alternatives.

Therefore the solution is groynes, built of natural rock. They will capture the sand and retain it on the beaches, and from there the wind and natural forces will regenerate the sand dunes.

It can be argued that the action of least impact is to do nothing. No additional carbon is released to atmosphere, and our fallacious self-belief in “creating a solution” is no longer sustained. However we created this situation, so we owe the natural world a course of remedial action which is as minimalist and as natural as we can devise.

Rock groynes provide this.

By this means natural sea defences are restored, and the sandy coasts of Norfolk and Suffolk retain their character, and their coastal inhabitants and economy are relieved of imminent disaster.



Rock reinforced original wooden groynes near Sea Palling, Norfolk at the termination point of the offshore rock reef, seen out to sea.



The (sand covered) promenade at Caister on Sea, showing the lines of marram with only a few of the original unsunk rocks still visible.

The Finances.

At the present time the Government levies a tax of £2 per tonne on the extraction of sand and gravel – the aggregate tax.

The UK aggregate industry extracts over 15 million tonnes of sand and gravel from the sea annually. This amounts to £30 million in public revenues.

This revenue is not ring-fenced for coastal defences. Yet it is not unreasonable to expect that some of it should be allocated to the defence of both the Norfolk and Suffolk coasts where they are experiencing erosion, and to coasts experiencing the same elsewhere.

This revenue should therefore be made available to finance the installation of natural rock groynes along the full length of the Norfolk and Suffolk coast defended by sand dunes. The aggregate industry will be asked to supply this material, and so should be paid for its services from this public revenue.

The alternative which allows the sand dunes and natural sea defence to actually disappear, which in many locations is now imminent, will mean the re-housing of the people and families displaced. If the cost of re-housing is estimated at £100,000 per house lost, then the cost is £1 million for every 10 new homes required.

The environmental and financial cost-benefit analysis falls clearly in favour of action involving the installation of groynes made of natural rock, and the remedy will endure into the future.



An aerial view of Winterton-on-Sea taken in 2003, showing the erosion of the beach, sand cliff and dunes. Ten years ago the beach extended to the lower left hand corner of the picture. Since then continuing erosion has taken a further twenty metres, resulting in the loss of the Coastwatch Lookout seen as the white tower. The edge is now up to the beach-side café seen just beyond.

The Proposal.

Marinet is therefore proposing collective action to solve this problem.

Government, coastal communities and coastal defence agencies, along with the aggregate industry must work together to achieve this solution, which is clearly achievable and urgently required.

The design concept is correct. Its engineering is proven, and it will deliver the desired outcome.

The finance is available, and the budgetary requirements are affordable.

Marinet is proposing to all parties:

Convene and join together. The solution exists.

The time to act is now.

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For an in-depth analysis of the issues covered by this Campaign Briefing, see "*Why Canute Failed - our defences against the sea*" published by Marinet, May 2008.
<http://www.marinet.org.uk/campaign-article/why-canute-failed>