Coastal Hazards, Climate Change and Geo-Resilience
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Discussion introduced by Roger Moore, Professor Emeritus of Applied Geomorphology, University of Sussex and Global Principal of Geoscience and Engineering Geology at Jacobs UK

Climate change is a very impressive issue for society with in the UK, drier summers, wetter winters and extremes of weather, which have already impacted the rail network, some of which began in the 1850s (~170 years old) which was vulnerable to slope failures. Our coastline is subject to sea level rise and under a low to medium CO2 emission scenario, we can expect up to a metre rise within this century. Unless the coastal protection facilities are built up to 7m above Ordnance Datum, we can expect waves to overtop these defences, particularly on the IoW. Such projections will have very serious consequences globally, especially for our coastal cities. The high CO2 scenario, by the way, is up to a 2.5m SL rise, driven by changes to the W Antarctic ice sheets and mountain glaciers.

There are approaching 9 billion people on the planet, two billion more since 1942, which has happened because we know how to use the planet's resources. The recent IPCC report says clearly that "there is unequivocal evidence that greenhouse gas emissions are causing an irrevocable climate change'. This is a global challenge for decision makers to take pre-emptive actions and build resilience for the future. This is not new, our own Thames Barrier was built decades ago, but we can expect the coastal situation to get a lot worse and we need to enhance these efforts through long-term planning; but wherever one looks around the world, the political framework is entirely short term.

A good example of this is to ask why developments around the world have been permitted so close to the coast, yet these will certainly be impacted severely in the next 100 years? The risks are obvious and yet there is no institutional control, nor forward thinking. Holland may be the only country that does have an effective long-term planning system.

The UK has only rarely provided long term infrastructure plans; instead, we are dominated by the 5-year political cycle. In fact, there is nothing in our system to allow long-term planning, which is very frustrating for geoscientists and engineers. Governments of all kinds have simply sidestepped these aspects. Perhaps if the CEGB had been allowed to continue with modern pressurised water nuclear stations in the 1970s and 1980s, electrical power would have been there to provide for the current energy transition. If N Sea gas had not been used as a short term measure to generate electricity, could the offshore platforms have all been used subsequently as wind generating platforms?

There is also the fact that while climate change for a given aspect, say a serious storm, is often described as a once in 50-year event, but what does that actually mean on the ground? What exactly is likely to happen to, say, a rail embankment or a section of coastal wall? There is no data. What data was there to measure prior to the Lynton village destruction in 1952, or the recent destruction of Derna on the Libyan coast? Every location is different: groundwater flow, permeability, rock type, slope, rainfall etc, so predicting vulnerability is a vague art with many variables. Consequently, whatever we predict, from the point of view of a decision maker or funder, how reliable is it? How do you 'sell' a geo-resilient scheme when you are dealing with such high levels of uncertainty, especially with limited site investigation data, especially when the costs can be massive? This is where the political argument needs to carry weight so that local organisations are compelled to act or nothing will be done.

However, some organisations, such as Network Rail, have embarked on a geo-resilience programme, helped no doubt by the example of the Dawlish coastal railway embankment which, in 2014,

suffered eight consecutive greater than one-in-50-year storms in the space of two months; a sequencing of extreme weather events having a major impact on the railway, assisted by seawalls failing because they had not been maintained. It is possible to predict statistically, but not be specific, and clearly the normality of the past has gone.

One of the tools that is used is quantitative risk analysis where the best data available is captured collectively, which can frame uncertainties and therefore help in answering the question: what don't we know? For example, with the Fukushima disaster, no one had ever thought that a tsunami could get that big, so that possibility was not built into the model for its construction. It was beyond the known. The possibility of a meteorite impact would be another example of how do you assess the likelihood? How does the insurance business work? Normally, Acts of God!

The question of how the offshore oil and gas industry calculated its risks? Much was self-insured, for example BP in the Gulf of Mexico, which suffered extreme cost and much reputational damage as well. The oil industry has, however, achieved safe operations in some very harsh conditions in offshore development, because they have employed people who have studied the conditions, and there was enough at stake, dealt with by a wise Board. The confidence in building offshore windfarms has at least allowed the UK to build windfarms (albeit subsidised and therefore not independently economic) but at least we are not still building scores of coal-burning power stations like China and India!

The the overall consensus is that climate change is happening, but from a PR perspective, it would help if people telling us these things said, very simply, these events are happening and cut out the man-made aspect of it? This aspect can be managed over time, if necessary, whereas repetitively saying that it is a man-made disaster, is not helpful. If it were phrased differently, people will take it more seriously and plan for it. This is true whether the climate change is entirely a natural cycle (which geologists can see in the geologic record) or it is entirely anthropogenic.

What is one to say to a client? Regarding landslides for example, we have historical data to show how antecedent data from rainfall, landslide frequency and magnitude, but one still has to project forward. In UK we actually have quite a bit of forward planning done; we have identified risks, produced shoreline management plans and co-ordinated coastal groups, but we also have over half a million properties at risk of flooding and erosion. For our critical infrastructure (rail, nuclear, landfill, heritage sites) which have environmental safety plans which are required to look ahead scores or hundreds of years, as required by Government. Some of these plans necessarily depend upon planned retreat and let nature takes is course. The USA is apparently copying this approach. But nonetheless, while shoreline management plans are there, they are non-statutory and still subject to the 5-year political cycle of policy development.

A local example of nonsense planning occurs in Tonbridge, where local ponds on the valley sides were developed by the Victorians, but removed in the modern era because of H&S fears; the consequence is that the centre of the town now suffers serious flooding. Statutory long term thinking would be preferable to decisions made by local politicians!

Of course, away from the coast in the expanding Sahel naturally (as the Sahara changed from a grain growing temperate environment after the ice age) but particularly over the past half century, and with a burgeoning population, climate change is operating there too but with no mitigation, people

migrate northwards. Previous multinational plans for the so-called Greening of the Sahara failed completely.

The really scary thing in this country is the increased frequency of extreme weather events, which in some cases appear to be about a tenfold increase above historical data.

The Carmont train disaster west of Stonehaven, was actually the result of a flawed drain design and a considerable fine resulted: "The record £6.7 million fine imposed on Network Rail over the Carmont rail crash is designed as a punishment for failings that led to the deaths of three people and a deterrent to prevent a repeat of similarly deadly incompetence. Although rail industry executives are far from the only ones who should heed this warning."

John Bennett