SEDIMENTATION

The muddy nature of the Severn estuary is the product of a high sediment load maintained in suspension by the exceptionally strong currents in the estuary. These currents, which are much stronger on the flood than the ebb, are the primary mechanisms determining the shape and content of the seabed in the different reaches of the estuary. The deeper channels are composed of scoured rock or gravel while the inter-tidal areas are characterised by mud banks.

Other sediments in the estuary include clay, sand and shingle. This sediment is sourced from a number of locations including rivers, cliff erosion, saltmarsh erosion, mudflat erosion and the sea floor. There are a number of sandbanks in the estuary, such as Middle Ground, that have accumulated through a “tidal pumping” mechanism which pushes sand upstream on the strong flood tides in deposits which the weaker ebb is unable to remobilise. Mud on the other hand appears to remain in permanent suspension, washed up and down the estuary on each tide.

It is a process that is still not completely understood and it follows from this that the precise effects of a barrage on this regime are also unclear. What is certain (SDC Turning the Tide) is that it would have a major effect on sedimentary transport by reducing the tidal force on the seabed outside by a factor of four during flood tides and a factor of ten during ebb tides. This would lead to a significant reduction in sand transport and the deposition of muddy silts. While the SDC note that attempts have been made to tackle the issue of the deposition of sediments that could “significantly reduce the operating lifetime of a barrage” no solution has been found yet. It estimates that the barrage could possibly allow the river to deposit up to 85% of its currently mobile sediment load, clogging navigable channels, silting up the basin and possibly the beaches of North Devon and South Wales.

If this is true and the lifespan of the barrage is limited by the deposition of silt, can it really be said to be sustainable? The Save Our Severn Campaign claim that much theoretical research and real practical experience in Canada shows the problems that can result from barraging tidal estuaries with high sediment loads. They quote the work of Dr.Graham Daborn from the Acadia University Centre for Estuarine Research, Nova Scotia, an acknowledged expert in this area of study.

He gives three examples of dams built across macrotidal estuaries in Canada where their construction diminished previous water velocities. They are the Petitcodiac causeway built in 1955, the Annapolis causeway in 1960 and the Windsor causeway in 1970. Two of these constructions, at Petitcodiac and at Windsor, have caused massive deposition of sediment on both sides of the dam walls. At Windsor, accumulation on the seaward side during the first year occurred at rates of up to 15 cm/month until it reached the mean high water level (i.e. about 8 m in thickness). Now, after 38 years, the new mudflat is still growing down the estuary and is causing increasing problems for shipping at the port of Hantsport, some 11 km away from the dam.

The Annapolis Causeway had the opposite effect: it has accumulated a large amount of sediment upstream of the dam which is steadily filling in the headpond, but appears to have induced accelerated erosion on the seaward side, threatening one of Canada's most important historic sites.

In all three cases, construction of the dams caused massive deposition of suspended sediments but with two different results.

The reason for these differences is connected to the source of the sediments in each case. At Petitcodiac and at Windsor, the major sources of sediments were from the seaward side, generated by the erosion of sea cliffs subjected to tides of up to 16m range. The sediments accumulating behind the dams were mostly derived from agriculture-induced erosion upstream.

At Annapolis, most of the sediment was derived from upstream, and, prior to building of the causeway, this was maintained in suspension by a tidal system that oscillated from 5 to 9 m in range. When the dam was built, all upstream sediment tended to settle out as flows decreased, and got trapped in the headpond. In addition, any sediment in water brought in from the sea that passed through the open fishway in the dam also got trapped upstream. This had the effect of creating a sediment deficit in the tidal water on the seaward side, and thus caused the greater erosion occurring along the shore of the Annapolis Basin.

The Save Our Severn campaign claims that other work by UK and Dutch scientists shows that the fine sediments that dominate suspensions in the water column of macrotidal estuaries do not behave in any way like non-cohesive sediments (e.g. sands) that engineers have traditionally used as models to understand patterns of estuarial sedimentation.

Their settlement rate depends upon particle size, salinity of the water, temperature, the mineralogy, the organic content, and the presence and activity of biological factors such as bacteria and phytoplankton. Once settled on the bottom, these sediments continue to display entirely unique properties. If allowed to dry out, as occurs in intertidal locations, the sediments may become extremely resistant to erosion, especially when low tide occurs in the middle of the day. In Minas Basin, (Canada) for example, it was found that over a two month period in summer the stability of the mudflat increased by several orders of magnitude because the sediments were held together by mucus secretions from benthic diatoms, bacteria, molluscs and worms. This is a seasonal phenomenon that causes sediments to settle and stay on the bottom, building up a bank that may accumulate many centimetres over the summer. When the sediments were examined in traditional ways in an engineering laboratory, it was found that they could be up to 80 times more resistant to erosion than one would have predicted on the basis of their grain size.

In order to accurately predict the effects of a barrage across the Severn, scientists need to know in detail sediment concentrations, sediment type (mineralogy and grain size), organic content, current velocities, shear velocities, turbulence, wave height and period, diatom concentrations and growth rates, invertebrate types and densities, and important vertebrates such as fish and birds that have major effects on benthic invertebrates. Such information takes years of study to collate and interpret yet without it predictions about the effects of the barrage, or for that matter tidal lagoons, on the fisheries, ports and tourist beaches of the Severn and Bristol Channel are just guesswork.

LA RANCE BARRAGE

Promoters of the Severn Barrage are keen to draw attention to the Rance barrage as a model that demonstrates both the benign impact of barrage technology and the efficiency of power generation by this method. It is certainly a fact that power has been generated from the site almost non stop since 1966 and that the estuary is still valued for its wildlife populations which have, in fact, increased in the interim. However the comparison is not of like with like. Indeed, power generation by any method, anywhere, will always have site- specific impacts that are not readily transferable to other locations.

The 240 MW La Rance barrage, which operates in both ebb and flow mode, is around 20 times smaller than an 8,640 MW Severn scheme. It is barely half a mile long, compared to nearly 10 miles, impounds just 9 rather than 185 square miles, and generates around 0.64 TWh per year, less than 4 % of a projected Severn barrage.

The ecology, the geography, and the scheme design itself are all different and so comparisons are of limited relevance. There has also been a lack of pre and post barrage studies at La Rance on which to base authoritative conclusions about ecological effects.