The Tides of South-west England

Ever since early man came to the shores of SW England he would have been aware of the rhythmic rise and fall of the sea. It would not have taken much observation to realise that there were about two tides every day and that when high water (HW) took place in the morning and evening they were much higher than when they occurred in the middle of the day. At the same time, since early man was a great observer of the night sky, he would have seen that the changes in the times of the largest and smallest tides during the day related to different phases of the Moon. Thus high (spring) tides coincide with full and new moons, and low (neap) tides with the first and third quarters of the moon. (Elsewhere, such as the Suffolk coast, the spring/neap pattern is the same except that it's HW springs, rather than HW neaps, that are in the middle of the day).

Today, we have the benefit of comprehensive measurements and understanding of the motion of the heavenly bodies, combined with the analysis of a series of systematic, long, in situ and careful observations of tidal levels from many different stations around the British Isles. By analysing these data (with 'harmonic' analysis) and with some computer modelling the UK Hydrographic Office (UKHO) is able to make accurate predictions of tidal levels for very long periods of time.

The adjective 'accurate' might seem overstated to some who visit rocky shores and find the level or time of low water (LW) to be not what they expected. There are a number of reasons for these 'inaccuracies', some natural and some man-made. We consider the man-made ones first. There are many sources of tidal predictions on the internet, some of which are free and extend well into the future. These predictions may be good enough for leisure use but are not used by large ships trying navigate their way into a shallow commercial port, who rely on UKHO predictions, and nor should they be used by rock poolers. The problem with internet predictions is that their provenance and datums are often unknown. Many are based on analysis of open source global satellite altimeter observations interpolated and extrapolated with computer models. Their problem is that the rate of progress and range of the tidal wave around the British Isles is complicated by the variability of bathymetry and coastline. Furthermore the frequency and separation between altimeter observations are determined by the track of the satellite and may not be suitable for tidal analysis near a shore. Thus although the predictions follow the phases of the moon, as observed by early man, they will not be as accurate as those of UKHO.

What about the natural reasons for UKHO imprecisions? They can be divided into four categories: a) local surges due to wind and wave set up; b) large scale surges due to atmospheric pressure changes (the 'inverse barometer' effect in which a 1 mbar increase in atmospheric pressure naturally depresses the sea level by 1 cm), c) basin scale long wave propagation through the Celtic Sea or English Channel; and d) shallow water effects that modify the shape of the deep water tidal wave and invalidates the harmonic tidal analysis technique. In certain places, for example in the higher reaches of estuaries, the rate at which water level drops decreases dramatically towards LW making its exact time difficult to estimate (and in practice not particularly relevant). By contrast, the rising tide can be surprisingly fast.

Just as a positive surge can lead to flooding and landslip, so a negative surge can reveal prehistoric forests and marine life in the sub-littoral (particularly when this coincides with a low spring tide). Forecasting surges is important for flood defences and navigation but is often difficult to do in practice because of these factors and the desire to time the maximum surge correctly with the time of HW or LW.

One other thing that can cause confusion is the choice of appropriate datum level. The Admiralty (UKHO) Tide Tables and charts define their 'Chart Datum' as the Lowest Astronomical Tide (LAT) (i.e. the lowest predicted tide) for a port or chart. The confusion comes about because other tidal predictions are based on different datums - thus an Admiralty tidal height of, say, 1.0 m may be calculated as 0.6 m from another source. By contrast the Ordnance Datum level OD(N) used on Ordnance Survey maps is defined as the mean sea level at Newlyn, Cornwall between 1915 and 1921 and applies to the whole of the island of Great Britain. Thus the height difference between OD(N) and Admiralty Chart Datums varies around the coast of South West England. For example, at Teignmouth, the difference is 2.57 m, whilst at Ilfracombe it is 4.80 m.

Toby Sherwin