CHOOSING A CHART DATUM

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1. The analysis described here was undertaken as a result of reading the very excellent article of Commander GORDON (The Rationalisation of Chart Datum in the British Isles) published in the Jan. 1968 issue of the International Hydrographic Review [1].

2. Since the advent of digital computers has completely revolutionised the practical problem of producing tidal predictions, it was decided to take full advantage of the new power this has conferred. Since we acquired our first computer in 1964 our computing facilities have steadily improved, leading to a spectacular decrease in the amount of machine time required to turn out a set of predictions. We are currently using a Rand Sperry Univac 1106 which is a powerful third generation computer. This is roughly two orders of magnitude faster than the I.C.T. 1301 with which we started.

3. The tides in South African waters are of the consistently semi-duirnal type, and the noise level is low. So far we have no record of a storm surge with an amplitude exceeding about two feet. It has been found that predicting from a set of 51 constituents gives excellent agreement between observed and computed levels. To get an idea of the amount of computer time needed to produce a 51 constituent set of predictions for a year for one port our prediction program was run on a number of different machines with the following results:

Machine	Time
ICT 1301	6 hours
IBM 1130	1 hour
IBM 360/40	10 minutes
ICL 1903A	8 minutes
Univac 1106	4 minutes

4. The fact that a set of predictions for a year can be turned out in four minutes makes it a matter of practical politics to predict for many years ahead in the search for the lowest astronomical tide (LAT). In the course

of this project it became expedient to coin a set of new acronyms, given as follows:

LATOM : Lowest Astronomical Tide of the Month;
LATOY : Lowest Astronomical Tide of the Year;
LATOFF : Lowest Astronomical Tide of the Foreseeable Future;

with HATOM, HATOY and HATOFF as the corresponding highest astronomical tides.

5. Since secular changes in mean sea level are known to occur it would seem that LATOFF, rather than LAT, would be a more rational parameter to use for choosing a chart datum. The time period we have chosen for looking ahead is thirty years, since it is pointless to try to peer into the future further than this. We have accurate sea level records for Simon's Bay going back to the beginning of 1958, and if there have been any secular changes in mean sea level during this period they are too small to be detected. It would therefore appear that it is not an unreasonable extrapolation to assume that secular changes during the next thirty years will not be significant.

6. Since we have these accurate Simon's Bay records it was decided to use Simon's Bay as the first port for which an investigation into LATOFF would be made. Ultimately it is intended to extend the analysis to all South African ports. Predictions for Simon's Bay were carried out for the years 1971 up to and including 2002 and LATOM taken out for each month of each year. For a given year the minimum of the LATOMs gave LATOY, and the minimum of the complete set of LATOYs gave LATOFF, and at the same time the various HATOMs, HATOYs and HATOFF were found.

7. The chart datum at present in use for Simon's Bay is a reference plane 2.63 feet (0.802 metre) below mean sea level. Referred to this datum LATOFF will occur at 2206 hours on Thursday September 25, 1980 when predicted sea level will fall to 0.71 foot below the present datum. HATOFF will occur at 0412 hours on Thursday March 9, 1989, when the predicted level will be 6.07 feet above the present datum.

8. From the foregoing it would thus appear that a more realistic value for chart datum would be:

$$2.63 + 0.71 = 3.34 \text{ feet}$$

9. Once one has got thirty years ahead with one's predictions it is no extra trouble to stay thirty years ahead. The predictions are simply stored on magnetic tape, and are brought down and printed out on prepared stationery as required for publication. Should it now be decided to change the datum, then any future changes of datum need only be made after thirty years' notice has been given.

10. The values of LATOY and HATOY obtained were plotted as graphs. These are shown in figures 1(a) and 1(b). These curves show a remarkable similarity to the ones shown in GORDON's paper, complete with the four

year periodicity he draws attention to. This periodicity is therefore not limited to the waters around Britain, and may in fact be a universal and as yet unexplained phenomenon.

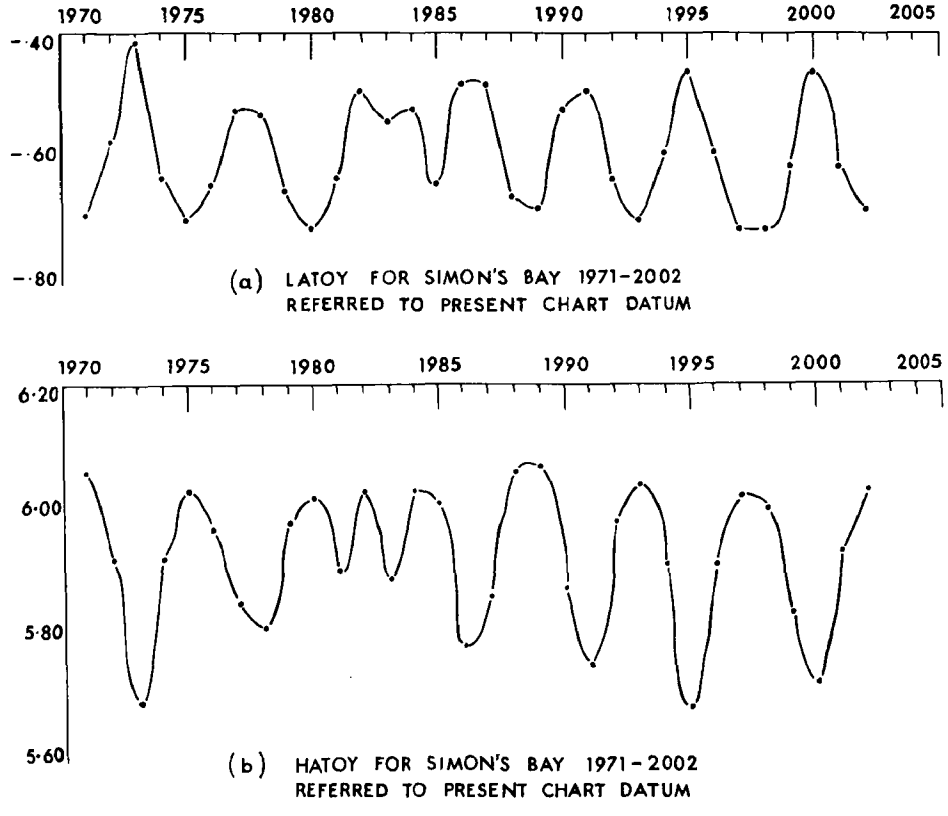

FIG. 1

11. GORDON makes the point that none of the empirical formulae based on harmonic constants gives a realistic datum. A check on the results we obtained serves to bear this out. The amplitudes of the principal harmonic constituents for Simon's Bay are as follows (in feet):

Name	Amplitude
M_2	1.669
S_2	0.744
K_2	0.213
O_1	0.058
K_1	0.193

The various formulae against which our value of LATOFF was compared are:

(a) Indian Spring Low Water $M_2 + S_2 + K_1 + O_1 = 2.66$

(b) Mean Spring Low Water $M_2 + S_2 = 2.41$

(c) Chart Datum for British Admiralty $1.1\ (M_2 + S_2) = 2.65$

(d) Lowest possible Low Water $1.2\ (M_2 + S_2 + K_2) = 3.15$

Since our value of LATOFF was 3.34 feet below mean sea level, even the most pessimistic of the formulae gives a value for the reference plane which is too high.

12. Before closing, there is one more point to consider, and that is the question of choosing a datum for a new harbour. As a tide gauge will presumably have been installed in anticipation of developments, the first thing to do would be a major analysis giving say 50 or more tidal constants. This could then be used to predict for thirty years ahead to obtain a value of LATOFF.

REFERENCES

[1] GORDON, D.L. : The Rationalisation of Chart Datum in the British Isles. *International Hydrographic Review*, XLV, (1), Jan. 1968.

[2] DRONKERS, J. J. : 1964 Tidal Computations, p. 100. North-Holland Publishing Co., Amsterdam.