Table 2.1 presents a summary of the main conclusions on the relative merits of each gauge technology based on the previous sections of this Volume. The Table also includes an estimate of the likely cost of a basic system with gauge, data transmission (e.g. modem) and meteorological package, although this is an extremely difficult thing to quote given the large number of manufacturers, monetary exchange rates etc. For example, the cost of a pressure transducer will vary by a factor of 3 depending if one wants a good-quality device or not. With these reservations in mind, Cost Band 3 has been set as the highest cost which might be of the order of 12-20K US$ (at the time of writing and within a large band, say 30%); Band 2 might be of the order of 8-12K and Band 1 approximately 5-8K. However, in our experience the real costs of any tide gauge station are those of installation (e.g. some kind of engineering support will be needed for installation of a stilling well, acoustic sounding tube gauge, or 'B gauge'; diver support will be needed for pressure gauge installations etc.), ongoing maintenance and data analysis (with implications for staff resources). Anyone planning a gauge installation, therefore, has to take into account all the local costs as well as the up-front costs of gauge hardware. Agencies participating in GLOSS which require the input of expertise may wish to explore the possibilities of collaboration with other GLOSS participants.

Our recommendations are:

- If one is planning a new 'GLOSS' tide gauge station in a mid- or low-latitude location, one should probably opt for:

    (1a) an acoustic gauge with sounding tube, unless
    (1b) a 'B gauge' is a feasible option

If low tidal range or other factors preclude the use of a 'B gauge', then a single transducer pressure gauge, a bubbler pressure gauge or a pressure transducer in a stilling well would be options.

- If one is planning a new 'GLOSS' station at a higher-latitude site which has sea ice cover for part of the year, one should probably opt for:

    (1) a single transducer pressure gauge, or
    (2) a bubbler pressure gauge

Although it is true to say that float gauges have been operated in Antarctica, and the longest tide gauge record in Antarctica is from the Faraday/Vernadsky float gauge in a heated stilling well, we do not recommend their future use in ice areas. Bubblers and acoustic gauges have also been tried in Antarctica but our recommendation is to use the single transducer systems if possible, with summer-time datum control using either tide poles or 'temporary B gauges'.

- If one is planning to upgrade an existing float gauge 'GLOSS' installation at most places, then we would recommend:

First consider simply upgrading the existing system to electronic data acquisition and transmission. (Charts must go as the main recording system although they can remain to provide ancillary information.) This will provide instructive experience with real time data.

Second consider the use of a pressure gauge system within the stilling well.

Then consider installation of a new station alongside the old one (either acoustic sounding tube or 'B gauge' etc. as described above) but keep both operational for inter-comparison of their data for an extended period (possibly as much as a decade).

- If one is planning to use relatively cheap gauges (but perhaps many units) for 'C-GOOS' purposes, then we would recommend:

  (1) single transducer pressure gauges
  (2) if existing (or easily installed) stilling wells are available, fairly inexpensive shaft encoder float systems now on the market
  (3) if wells are available, pressure transducers in the well

- If one required a 'cheap and cheerful' gauge for 'Practical' harbour operations or approximate flood level estimates, then we would recommend:

  (1) single transducer pressure gauges
  (2) acoustic gauges in open air

Such installations would not need the ancillary parameters needed for GLOSS (Appendix 1, point vi) but they may require components such as 'user friendly' real time displays.

Whichever type of gauge is selected, advice will be needed. The GLOSS-related scientists listed in Table 2.2 have agreed to provide detailed advice on each gauge type if contacted.

Table 2.1

Acoustic Gauges with Sounding Tubes

Pro

Complete ready-to-go packages (acoustic transducer, sounding tube, met package, ancillary sub-pressure sensor, modem etc.) can be purchased from several manufacturers. This technology is now used in some of the largest networks (e.g. US, Australia) and hence there is considerable experience of it.

Con

For best accuracy a calibration facility is required. In areas of large tidal range a long sounding tube is required which may result in magnified temperature and/or temperature-gradient effects.

Consensus Accuracy < 1 cm

Cost Band 2

Acoustic Gauges in the Open Air

Pro

Relatively low cost.

Con

Larger errors due to air temperature effects than for the sounding tube method. Less rigorous method of establishing a calibration (by use of a sounding bar in the open air rather than the acoustic reflector in the sounding tube).

Consensus Accuracy >1 cm depending on the quality of the installation

Cost Band 1

Single Transducer Pressure Gauges

Pro

Precise (if not accurate datum) time series of pressure can be acquired (temperature calibration required for best results) with less potential noise due to surface effects than in an acoustic or float gauge. Can be readily purchased from several manufacturers. Systems which integrate over a time period rather than spot-sample are to be preferred.

Safe location beneath the water line and no large structures (e.g. stilling well) required. Suitability therefore for operation in environmentally hostile areas.

Con

Difficulty of establishing a datum and of monitoring changes in the effective datum. Therefore a need for additional datum information (e.g. from regular tide pole measurements).

Consensus Accuracy several mm precision (but not datum accuracy)

Cost Band 1-2

Multiple Pressure Transducer Systems (B Gauges)

Pro

Extremely accurate systems with automatic datum control and, as a by-product, air pressure data without a separate barometer in addition to air and sea temperatures.

Con

(So far as is known) the technique is used only by POL to date although there are plans for commercial manufacture. Three transducers result in a relatively expensive system. Technique can work only given a sizeable (> 1 m) tidal range.

Consensus Accuracy several mm precision and accuracy

Cost Band 3

Pressure Transducers in Stilling Wells

Pro

As for 'B gauges' above, without the cost of a third ('B') transducer, as long as a stilling well is available.

Con

Well-known problems associated with the use of stilling wells.

Consensus Accuracy 1 cm approximately. Absolute accuracy will be limited by the characteristics of the well.

Cost Band 2

Bubbler Pressure Gauges

Pro

Many of the same advantages as the single transducer system.

Con

Slightly more maintenance-intensive than single transducer systems, requiring compressor and bubbler gas flow system, in addition to pressure transducer and data logger. Degraded performance in the presence of high wave conditions.

Consensus Accuracy 1 cm (worse in high wave conditions)

Cost Band 2

Float Gauges

Pro

Tried and tested traditional, relatively unsophisticated technology which (in principle) measures exactly the parameter required (sea level) rather than an indirect parameter (e.g. pressure or sound).

Con

Stilling well density and siltation problems. Need for bulky stilling well installations and consequent heavy civil engineering in areas of large tidal range.

Comments

Paper charts are no longer acceptable as the main data recording method (but are acceptable as an ancillary method) as they contain many sources of inaccuracy and require labour-intensive digitisation. Also note the GLOSS requirement for other parameters to be measured at a gauge site (e.g. air pressure) which implies that an electronic data logger system is anyway required at the station. Relatively cheap new shaft encoder systems may have possible useful application at some locations.

Consensus Accuracy 1 cm approximately (a complicated site-dependent function of many factors)

Cost Band 1-2

Radar Gauges

Consensus Little experience in the GLOSS community

Cost Band 1