ICES Guidelines for Water Level Data

(Compiled August 1999; revised August 2001; revised May 2006)

In the context of this guideline, water level data are considered to be measurements taken from digital or analogue gauges positioned at the waters edge. In some locations, water level measurements date back to the late 1800's and thus represent an important long time scale oceanographic measurement.

1.0 Receiving Data

The Data Centres require the following information to be supplied by the data supplier together with the data. When receiving data, the Data Centres of the ICES community shall strive to meet the following guidelines.

1.1 Data standard

Raw and quality controlled water level data should be, whenever possible, stored at the original sampling frequency. For water level data, hourly observations are recommended as a minimum. Nowadays, with the emerging technologies, most equipment is capable of measuring at 1 or 5 minutes interval. With this sampling frequency, not only the tides and mean sea level but also other phenomenon can be studied.

All parameters must be clearly specified and described. If parameter codes are to be used, then the source data dictionary must be specified. Parameter units must be clearly stated. Parameter scales must be noted where applicable. If computed values are included, the equations used in the computations should be stated.

All relevant calibrations should be applied to the data including laboratory and field calibrations. Instrument calibration data should be included in the data file. The data should be fully checked for quality and flagged for erroneous values such as spikes, gaps, etc. An explicit statement should be made of the checks and edits applied to the data. If any data values have been removed, the times of the removed values should be noted.

In particular:

- All data values should be expressed in oceanographic terms, in SI units, which should be clearly stated.
- The time zone in use should be clearly stated and each data cycle should include date/time of observation (without loss of precision). It is recommended that UTC is used.
- Other parameters measured as part of the series, e.g. temperature, pressure, conductivity, should be included with the data.
- A clear statement should be made on whether the data are supplied as sea surface elevation (either as measured or as converted from pressure measurement) or as pressure data. The relevant values of density and acceleration due to gravity required for conversion should be stated.

- A clear statement should be made on whether or not the data have been corrected for atmospheric pressure.

1.2 Format description

Data must be supplied in a fully documented ASCII format. Individual fields, units, etc. should be clearly defined and time zone stated. Time reported in UTC is strongly recommended. Ideally all of the data from the instrument should be stored in a single file, but annual files are also acceptable. The contents of the data and ancillary information should adhere to the Formatting Guidelines for Oceanographic Data Exchange (http://ocean.ices.dk/formats/GETADE_Guidelines.aspx) prepared by the IOC's Group of Experts on the Technical Aspects of Data Exchange (GETADE) and available from RNODC Formats.

1.3 Collection Details

Pertinent information to be included in the data transfer to the Data Centre:

- Name of the country and organisation responsible for the deployment or installation, recovery, collection and processing of the data. The name of the Principal Investigator or organisation responsible should be included.
- Supplier's identifier for the series (e.g. site name and number)
- Dates and times of the start and end of the data series
- Precise fixed time interval between observations in the series provided.
- Latitude and longitude, including the convention, precision and method of the position fix (e.g. DGPS, GPS, etc.)

Sufficient documentation should accompany each data series so as to ensure that the data are adequately qualified and may therefore be used with confidence by a secondary user. Such documentation should be stored alongside the data, and where applicable, should cover:

Instrument

- Instrument description, manufacturer, model, principle of measurement, method of recording - refer to publication or briefly describe.
- Pertinent instrument characteristics (See Annex A for specific instrument types)
- Instrument modifications and their effect on the data
- Method and times of calibration, to include calibration factors
- Frequency of cleaning, control of biological fouling
- Operational history

Site

- Brief description of location of tide gauge
- Description of tide gauge benchmarks
- Datum relationships
- Datum and leveling history

Data sampling/processing

Brief description of processing procedures used to obtain final data values including:

- Sampling scheme of raw data e.g. continuous recording, instantaneous, averaged
- Interval between samples and duration of individual samples (raw data)
- Number of raw data samples
- Nominal interval of processed data (excluding gaps resulting from editing, etc.)
- Methods of averaging, filtering or compression
- Gaps in the data record
- Timing and/or datum corrections applied
- De-spiking/smoothing/interpolating methods and editing procedures

Report on data quality
Report any quality control applied by the data supplier to the data set (manual or automatic) or any additional information of use to secondary users which may have affected the data or have a bearing on its subsequent use (e.g. effects of sea state, fouling, etc.).

2.0 VALUE ADDED SERVICE

When processing and quality controlling water level data, the Data Centres of the ICES community shall strive to meet the guidelines as specified in IOC Manuals and Guides No. 14: Volumes I, II and III.
(Available at http://www.psmsl.org/train_and_info/training/manuals/)

2.1 Quality Control

For water level data the World Ocean Circulation Experiment (WOCE) quality control guidelines (Rickards and Kilonsky, 1997; (Available at http://www.bodc.ac.uk/projects/international/woce/documents/odspaper.pdf).
are recommended. A range of checks are carried out on the data to ensure that they have been correctly imported into the Data Centre's format without any loss of information. These should include:

- General check of accompanying information (e.g. latitude, longitude, water depth for bottom-mounted pressure recorder data)
- Automatic range checking of each parameter
- Plot tide gauge/bottom pressure recorder positions to ensure no inland points
- Visual inspection of time series for all parameters supplied - this may include atmospheric pressure, sea surface temperature, meteorological parameters - in addition to sea level
- Flag suspicious data, including spikes, or correct after consultation with Data Supplier
- Pay attention to continuity of data (e.g. no datum shifts) from one year to the next particularly if the data are supplied annually.
- Check for consistency of water levels with historical observations from the same site
- Calculate daily, monthly and annual mean values and compare with historical database
- Tidal analysis to produce predictions and to compute residuals to check for timing problems or datum shifts. Resolve problems with data supplier
- Tidal constants produced by the analysis should be compared with the historical constants
- Time series of multiple stations for localised areas may be plotted and correlation

between neighbouring stations can be reviewed for inconsistencies
- Production of regular data reports such as 'Annual Summaries and Historical Extremes' and 'Monthly and Yearly Means' allow for continuous monitoring of the quality and consistency of the entire archive.

The standards for quality control of tide gauge observations recommended by the European Sea-Level Services (García, et all) are available at http://www.eseas.org/eseas-ri/deliverables/d1.2/ESEAS_QC_29032005.pdf, Two levels of Quality Control are considered, depending on the transmission time. Most of the quality checks are included in the above guidelines, nevertheless some (as follows) methods have been upgraded.

In level 1 for real or near real time:
- An adequate algorithm for detection of spikes in order to not flag as erroneous real phenomena like tsunamis and seiches.

In level 2 for delayed mode in order to check the historical data:
- Standard Normal Homogeneity Test
- Empirical Orthogonal Function (EOF Analysis)
- Mann-Kendall test for trends

A Scientific/technical paper relating to the above standard "European Sea Level Monitoring: Implementation of ESEAS Quality Control (García et all) is in press.

2.2 Problem Resolution

The quality control procedures followed by the Data Centres will typically identify problems with the data and/or metadata. The Data Centre will resolve these problems through consultation with the data supplier. Other experts in the field or other Data Centres may also be consulted.

2.3 History Documentation

All quality control procedures applied to a data set are fully documented by the Data Centre. As well, all quality control applied to a data set should accompany that data set. All problems and resulting resolutions will also be documented with the aim to help all parties involved; the Collectors, Data Centre, and Users. A history record will be produced detailing any data (including dates of the changes) changes that the Data Centre may make.

3.0 Providing Data and Information Products

When addressing a request for information and/or data from the User Community, the Data Centres of the ICES community shall strive to provide well-defined data and products. To meet this objective, the Data Centres will follow these guidelines.

3.1 Data Description

The Data Centre shall aim to provide well-defined data or products to its clients. If digital data are provided, the Data Centre will provide sufficient self-explanatory series header information and documentation to accompany the data so that they are adequately qualified and can be used with confidence by a wide range of users.

Additional information includes:

- A data format description fully detailing the format in which the data will be supplied
- Any ancillary parameters (e.g. temperature, salinity)
- Parameter and unit definitions, and scales of reference
- Definition of flagging scheme, if flags are used
- Relevant series header information included in the data file.
- Data history document (as described in 3.2 below)

Data products may also be provided including:

- Calculated daily, monthly and annual mean values and extremes
- Tidal analyses and constants to produce predictions
- Data reports such as 'Annual Summaries and Historical Extremes' and 'Monthly and Yearly Means'.

3.2 Data History

A data history document will be supplied with the data to include the following:

- A description of data collection and processing procedures as supplied by the data supplier
- Historical benchmark information and datum relationships
- Quality control procedures used to check the data.
- Any problems encountered with the data and their resolution
- Any changes made to the original data and the date of the change

Any additional information of use to secondary users which may have affected the data or have a bearing on its subsequent use should also be included.

3.3 Referral Service

ICES member research and operational data centres produce a variety of data analysis products and referral services. By dividing ocean areas into regions of responsibility, and by developing mutually agreed guidelines on the format, data quality and content of the products, better coverage is obtained. By having the scientific experts work in ocean areas with which they are familiar, the necessary local knowledge finds its way into the products. Data and information products are disseminated as widely as possible and via a number of media including mail, electronic mail and bulletin boards.

If the Data Centre is unable to fulfil the client's needs, it will endeavour to provide the client with the name of an organisation and/or person who may be able to assist. In particular, assistance from the network of Data Centres within the ICES Community will be sought.

REFERENCES

UNESCO. 1985. Manual on Sea Level Measurement and Interpretation. Volume I. Basic Procedures. IOC Manuals and Guides No. 14, 83pp

UNESCO. 1993. Manual of Quality Control Procedures For Validation of Oceanographic Data, Prepared by: CEC: DG-XII, MAST and IOC: IODE, Manual and Guide 26, SC-93/WS-19.

UNESCO. 1994. Manual on Sea Level Measurement and Interpretation. Volume II. Emerging Technologies. IOC Manuals and Guides No. 14, 72pp.

UNESCO. 2002. Manual on Sea Level Measurement and Interpretation. Volume III. Reappraisals and recommendations as for year 2000. IOC Manuals and Guides No. 14, 55pp.

Dynamic PLANET 2005, European Sea Level Monitoring: Implementation of ESEAS Quality Control. In press

Permanent Service for Mean Sea Level (PSMSL) "Training Information" Web pages at http://www.psmsl.org/train_and_info/

European Sea-Level Services (ESEAS). http://www.slrcop.org/eseas/eseas-ri/

Annex A

Recommended documentation relevant to common instrument types:

i) Acoustic gauge. Documentation should include whether the sensor operates within a sounding tube or in the open air, details of instrument calibration, details of temperature sensors, size of tube, ancillary sensors, details of datum control.

ii) Radar or optical (laser) gauge. As for acoustic gauge except for the need of temperature sensor(s)

iii) Step gauge. Documentation should include electrode diameter, electrode mutual spacing, sampling frequency and time averaging interval.

iv) Pressure transducer. Documentation should include a statement on whether the data have been converted to elevation, and the appropriate values of water density and acceleration due to gravity used/to be used in the conversion. Details of calibration and sensor drift, and whether drift has been removed. Information relating to atmospheric pressure, whether values are total pressure - or if atmospheric pressure has been removed.

v) Bubbler gauge. Documentation should include tube length, tube diameter, orifice diameter, density value used to convert to elevation, acceleration due to gravity and the formula used to compensate for tube length.

vi) Conventional stilling well. Documentation should include well diameter, orifice diameter, orifice depth below mean water level and orifice height above seabed.

vii) Bottom-mounted pressure recorder. Documentation should include a statement on whether the data have been converted to elevation, and the appropriate values of water density and acceleration due to gravity used/to be used in the conversion. Details of instrumental drift, and whether it has been removed.