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**Sea level change observation and impact assessment**

海平面变化观测与影响评价

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### 1 Scope

This document sets the main techniques and methods for sea level change observation and impact assessment and the application of the results.

This document applies to field observation of sea level change in coastal areas and to the assessment of the possible impact of sea level change, the evaluation of its risk and related work.

### 3 Terms and definitions

The terms and definitions given in GB/T 15920, GB/T 23694 and GB/T 26376 and the following apply to this document.

3.1 sea level. The mean height of the sea surface once all disturbances have been removed.

3.2 sea level change observation. Long-term, continuous and stable observation of tidal level carried out at a station set up on the shore or on an offshore installation, the sea level change data being obtained by averaging the observed tidal levels over a period of time.

## 4 Sea level change observation

4.1 Observation station. A sea level change observation station should be sited in a stretch of sea that is open to the outer sea, where the current is steady, where silting is unlikely and where wave action is slight, and should keep clear of coasts subject to heavy scouring or liable to collapse. At the local theoretical lowest tidal level the water depth should be greater than 1 m. Observation stations are to be spaced more closely in areas where extreme events are frequent and in coastal areas that are economically developed and densely populated.

4.2 Observation facilities and instruments. The tide well and the staff gauges inside and outside it shall be set up as required by 6.1.4 and 6.1.7 of GB/T 14914.2-2019. According to the observing environment, a station should use a float, pressure or radar type tide gauge or similar instrument. The instruments used shall meet 6.2 of GB/T 14914.1-2018. Stations that are able to do so, and newly built stations, shall install at least two sets of sea level change observation instruments for data comparison and back-up observation, so that the sea level record stays continuous.

4.3.1 Setting of benchmarks. The benchmarks of a sea level change observation station shall be set up as required by 6.1.6 of GB/T 14914.2-2019.

4.3.2 Levelling of benchmarks. Levelling of the benchmarks is carried out according to GB/T 12897 and 6.1.6 of GB/T 14914.2-2019. The benchmark elevation of a sea level change observation station is referred to the 1985 national height datum and shall meet GB 22021. Island stations whose relationship to the 1985 national height datum cannot be established may use an independent elevation.

4.4 Height datum for sea level change observation. The tidal datum of a station should be the local theoretical lowest tidal level. The relationship between the tidal datum and the 1985 national height datum is established through the staff gauge reading pointer, the check benchmark and the primary benchmark. Once fixed, the tidal datum should not be altered lightly.

4.5 Observation and recording. The elements observed are tidal height, high water height, time of high water, low water height and time of low water. Tidal height is given in centimetres to an accuracy of plus or minus 1 cm, and tidal time in minutes to an accuracy of plus or minus 1 min. Observation and recording follow 6.2 of GB/T 14914.2-2019. The station shall record and file any activity that affects the observation data, including changes of station site, changes in the surroundings, replacement of instruments and changes of tidal datum.

4.6 Analysis and calculation. Hourly tidal level data from continuous and stable stations are selected and the monthly mean sea surface is calculated by arithmetic averaging; annual mean and multi-year mean sea levels are then derived from the series of monthly means.

Where hourly tidal level data for a particular month at a station are seriously incomplete, the value may be derived by the correlation ratio method from the sea level change at a neighbouring station over the same period. Quality control of tidal level observation data follows 8.1.2 of HY/T 0315-2021, and the reference tidal level of a station is verified by the method of HY/T 180.

## 5 Data collection and analysis

5.1 Basic geographical data. Digital elevation model (DEM) raster data at a scale of not less than 1 to 50 000. Vector data for coastal administrative boundaries at provincial, prefecture, district or county and township level, for important settlements including provincial capitals, municipalities and major cities, and for transport including roads, railways and airports. Elevation data shall be referred to the 1985 national height datum, and the basic geographical data shall use the 2000 national geodetic coordinate system (CGCS2000) and meet GB 22021.

5.2 Shoreline and dyke data. a) Coastline data shall include attributes such as the name of the administrative area, the type of shoreline and the length of the section. b) Dyke data comprise the spatial distribution of dykes and their elevation; the spatial distribution data shall include attributes such as the name of the administrative area, the year of completion, the design protection standard of the dyke, the design elevation of the crest and the objects the dyke protects, and the elevation data shall include the crest elevation, the crest width and the elevation of the top of the wave wall. Elevation data shall be brought to a common reference in the 1985 national height datum. c) Data on the proportion of dykes meeting standard shall include attributes such as the name of the administrative area and the length and position of the section.

5.3 Land use data. Land use data comprise the first and second level classes of current land use, their spatial distribution and their area. The classification shall meet GB/T 21010-2017, and the coordinate system shall be brought to the 2000 national geodetic coordinate system.

5.4 Hydrological and meteorological data. Historical tidal level, wave and precipitation data for the assessment area are collected and the statistical characteristics of the relevant elements calculated. The amount of sea level rise is calculated by statistical and numerical prediction methods to give the rise over a future period, the result including a high, a middle and a low value. Tidal characteristics such as mean high water, mean spring high water and mean tidal range are calculated from the historical tidal level observations of the assessment area. Where an assessment area has no tidal level observations, the harmonic constants of the principal constituents, at least four of them, are first derived from a numerical tidal wave model and the tidal characteristics then calculated. Return period tidal levels are calculated from historical tidal level observations of at least 19 years using the Gumbel distribution or the Pearson type III distribution, and cover the 50-year, 100-year,

200-year and 1000-year high water levels among others. Where less than 19 years of historical observation is available, the annual extreme high water is first calculated by the synchronous extreme value ratio method against a neighbouring station, and the return period levels are then derived.

5.5 Data related to the ecological environment. Information on groundwater reserves, the distance of seawater intrusion, the area of coastal wetland and the rate of tidal flat erosion in the assessment area is collected.

5.6 Socio-economic statistics. Socio-economic statistics for the last five years for each evaluation unit, including total population, the number of townships and subdistricts, GDP, the number of industrial enterprises above a designated size, the number of major coastal engineering installations, population density, level of urbanization, output value density, the proportion of the population in employment, the number of professional disaster relief personnel, local fiscal revenue and investment in disaster mitigation.

## 6 Assessment of the possible impact of sea level change

6.1 Basic requirements. The area that a future sea level rise could reach is assessed from the DEM data of the assessment area, and the possible impact of the rise is then assessed together with the land use data.

6.2 Setting of scenarios. From the amount of sea level rise over a future period under different prediction scenarios, and taking the various characteristic tidal levels and return period tidal levels into account, the following scenarios are set: a) scenario 1, the sea level height, that is the mean tidal level, over a future period; b) scenario 2, the sea level rise over a future period plus the mean spring high water; c) scenario 3, the sea level rise over a future period plus a return period tidal level. The return period is chosen to suit the level of dyke protection in the area and the purpose of the assessment, and covers the 50-year, 100-year, 200-year and 1000-year high water levels among others.

6.3.1 Assessment of the possible impact area without dyke protection. Where coastal dyke protection is left out of account, the assessment works mainly from the combined water level  $H$  reached under scenarios 1 and 2 and from the DEM data of the area. The main steps are: a) reclassify the DEM data of the assessment area against the height  $H$  into two classes, greater than  $H$  and less than or equal to  $H$ ; b) convert the data less than or equal to  $H$  into vector data and merge adjacent areas; c) clip the resulting data to the assessment area to obtain the land area affected by the sea level rise; d) applying the principle of connectivity, remove isolated inland islands, and the data extracted are the possible impact area.

6.3.2.1 No overtopping. The combined water level under scenarios 1, 2 and 3 is compared with the lowest crest elevation; where the combined water level is below the crest, no overtopping occurs.