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中国海洋工程咨询协会
China Association of Oceanic Engineering

Social Organization Standard

T/CAOE 20.8-2020

Technical guideline for investigation and assessment of coastal ecosystem —

Part 8:

Sandy coast

海岸带生态系统现状调查与评估技术导则 第 8 部分：砂质海岸

（English Translation）

Issue date: 2020-05-06 Implementation date: 2020-05-06

Issued by China Association of Oceanic Engineering

Contents

Foreword

The T/CAOE 20 *Technical Guideline for Investigation and Assessment of Coastal Ecosystem* consists of the following ten parts:

——*Part 1: General;*

——*Part 2: Remote sensing identification and results verification of the coastal ecosystem;*

——*Part 3: Mangroves;*

——*Part 4: Salt marshes;*

——*Part 5: Coral Reefs;*

——*Part 6: Seagrass bed;*

——*Part 7: Oyster Reef;*

——*Part 8: Sandy Coast;*

——*Part 9: Estuary;*

——*Part 10: Bay.*

This is part 8 of the T/CAOE 20, which is used together with Part 1.

This part is drafted in accordance with the rules given in the GB/T 1.1-2009.

This part was proposed by the *Marine Early Warning and Monitoring Division, Ministry of Natural Resources*.

This standard was prepared by the *China Association of Oceanic Engineering*.

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Technical guideline for investigation and assessment of coastal ecosystem — Part 8: Sandy coast

1 Scope

This section of T/CAOE 20 specifies the working procedures, contents, methods and ecological status evaluation requirements for the survey and evaluation of the status of sandy coastal ecosystems.

This part applies to the survey and evaluation of the status of sandy coastal ecosystem.

2 Normative references

The following references are essential to the application of this document. For all dated references, only their dated versions are adapted to this document. For all undated references, their newest version (including all revision lists) applies to this document.

GB/T 12763.8-2007 *Specification for oceanographic survey: Part 8: Marine geology and geophysics survey*

GB/T 12763.10-2007 *Specification for oceanographic survey: Part 10: Submarine topography and geomorphology*

GB 17378.3-2007 *The specification for marine monitoring: Part 3: Sample collection, storage and transportation*

GB 17378.4-2007 *The specification for marine monitoring: Part 4: Seawater analysis*

GB 17378.5-2007 *The specification for marine monitoring: Part 5: Sediment analysis*

GB 17378.7-2007 *The specification for marine monitoring: Part 7: Ecological survey of offshore pollution and biological monitoring*

GB/T 17501-2017 *Specification for marine engineering topographic surveying*

HY/T 255-2018 *Technical guide for beach nourishment and restoration*

LY/T 1820-2009 *Technical regulation of research on wild plant resources*

T/CAOE 20.1-2020 *Technical guideline for investigation and evaluation of coastal ecosystem Part 1: General*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1

sandy coast

a coast constructed primarily with wave actions, and consisting mainly of sands (gravels) [GB/T 18190-2017, definition 2.2.7]

3.2

sandy coast ecosystem

a natural system composed of sandy shoals and their biocoenosis interacting with the surrounding environment

3.3

beach characteristic

beach topography and sediment features

3.4

foreshore

a zone between the mean high water line and the isobath of chart 0/(m)
[GB/T 18190-2017, definition 2.1.4]

3.5

backshore

a zone from the coastline to the mean high water line
[GB/T 18190-2017, definition 2.1.5]

3.6

inshore

a zone from low water line to the position where the wave action carrying sediment in cross-shore direction is limited (i.e., closure depth)
[GB/T 18190-2017, definition 2.1.7]

3.7

beach berm

a flat, stepped deposition located on the frontier of backshore front
[GB/T 18190-2017, definition 2.3.8]

3.8

submarine bar

an underwater ridged deposition parallel to the coast in a breaker zone
[GB/T 18190-2017, definition 2.3.15]

3.9

threat factor

natural or anthropogenic influencing factors that constrain the stability and development of sandy coastal ecosystems

3.10

coastal erosion

geological disasters such as the retreat of coastline, shoreface erosion, narrowing and steepening caused by natural and anthropogenic factors
[GB/T 18190-2017, definition 5.5.1]

3.11

coastal erosion intensity

an extent of coastline retreat or beach erosion

4 General rules

4.1 Working procedure

4.1.1 General requirement

The working procedure shall comply with Clause 5 of T/CAOE 20.1.

4.1.2 Special requirement

A combination of remote sensing image recognition and field survey results is used to determine the sandy coast survey zone. The following data shall be collected in the preparation stage:
--Coastal zone geology and topography (geological background, types of coastal geomorphology, etc.);
--Hydrological data (tides, ocean currents, waves, sea levels, river runoff, sediment concentration and its diffusion scope) in the past five years;
--Meteorological data (seasonal and annual changes of wind speed, wind direction and precipitation, as well as disastrous weather) in the past five years;
--Status of coastal development and utilization and social and economic conditions;
--Topographic maps, sea charts and satellite pictures of the survey zone.

4.2 Quality Control

Quality control shall be carried out in accordance with requirement 4.3 in T/CAOE 20.1.

4.3 Design of survey plan

The survey plan is designed in accordance with the requirements of Clause 6 in T/CAOE 20.1.

4.4 Working Achievements

4.4.1 General requirements

The achievements of the work shall be carried out in accordance with the requirements in T/CAOE 20.1, 9.1.

4.4.2 Special requirements

The survey and evaluation report outline shall be prepared in accordance with the requirements in Annex A.

4.5 Achievements archiving

Achievements and archiving shall be performed in accordance with the requirements of Clause 10 in T/CAOE 20.1.

5 Contents of status survey

The survey contents of sandy coastal ecosystems include beach characteristics, biocoenosis, environmental elements and threat factors. The survey contents, survey elements, and survey methods are shown in Table 1. Different elements of the survey can be selected according to the scopes of the survey and the needs of the evaluation.

The overall survey scope is as follows:
a) In cross-shore direction: stable artificial structures or the range from seaward of closure depth to 50m landward of mean high spring tide level, see Annex B for details;
b) In alongshore direction: independent sandy coast unit.

Table 1—Contents and methods of sandy coastal ecosystem survey

Survey contents	Survey elements	Survey approaches	Survey methods
Beach characteristics	Coastline: Position and length of current and historical coastline	Field survey, remote sensing survey	See 6.1.1
	Topography: Backshore, foreshore, inshore profile topography	Field survey	See 6.1.2

	Coastal morphology: berm, erosion scarp, sand ripple, submarine bar	Field survey	See 6.1.3
	Sediment: grain size parameter and gravel shape parameter	Field survey	See 6.1.4
	Offshore dynamic environment: wave, ocean current, suspended sediment, tide level, wind, regional sea level	Data collection	See 6.1.5
Biocoenosis	Intertidal organisms: functional types, populations, and distribution characteristics	Field survey	See 6.2.1
	Backshore vegetation: vegetation types, species, areas, number, height, DBH, canopy, coverage and vitality	Field survey &remote sensing survey	See 6.2.2
Environmental elements	Water Environment: fecal coliform group, water color, water temperature, salinity, transparency, PH value, petroleum and dissolved oxygen (DO)	Field survey & data collection	See 6.3.1
	Substrate environment: fecal coliform group, petroleum, organic carbon and sulfide		See 6.3.2
Threats	Natural factors: typhoon, storm surge	Data collection, field survey & social survey	See 6.4
	Anthropogenic factors: coastal structures, sea water pollution, fishing and breeding, artificial sand mining, deforestation, forest disasters, beach garbage, etc.		See 6.4

6 Methods of status survey

6.1 Survey of beach characteristics

6.1.1 Coastline

6.1.1.1 Stations layout

The method of stations layout is as follows:
a) Select the elevation points of multiple coastline features collected on the beach during spring tides (the field site identification features of coastline positions are the most landward garbage accumulation zone, the dry and wet boundary of the beach or the erosion scarp), and take the average value as the coastline elevation;
b) During coastline measurement, topographic points are collected at certain intervals along the elevation contour line, and the coastal measurement range covers the coastline within the entire beach unit.

6.1.1.2 Survey frequency

The surveys shall be conducted in summer and winter every year.

6.1.1.3 Technical requirements

Technical requirements are as follows:
a) Requirements for field measurement include the following terms:
--According to the length of sandy coastline, the survey scale shall be 1:500 or 1:1000;

--The plane positioning accuracy shall be higher than 0.05/(m);
--Other measurement requirements shall comply with the provisions of section 10.3 of GB/T 17501-2017.
b) The requirements for remote sensing image extraction include the following terms:
--The resolution of satellite remote sensing image shall be higher than 0.6/(m) and the mapping scale precision shall be no less than 1:500;
--The remote sensing image resolution of UAV shall not be lower than 0.1/(m), and the mapping scale precision shall not be less than 1:1000.

6.1.2 Profile topography

6.1.2.1 Stations layout

The method of stations layout is as follows:
a) A representative profile shall be selected to be vertical to the coastline and arranged uniformly according to the scale of the coast, and its range shall be from the backshore to the closure depth; If the beach alongshore length is no longer than 2/(km), at least 4 profiles shall be set. If profile length is in the range of 2~5/(km), the alongshore number of measured profiles shall be no less than 8. If the beach alongshore length is longer than 5/(km), at least 10 profiles shall be set.
b) Layout of benchmark points can select the position that cannot easily be destroyed by natural or human forces, or the movable position; Measuring with high precision position measuring instruments as well as layout virtual benchmark points can be an alternative.
c) The measuring point shall be able to reflect the changes of the profile topography. Filling in the survey form of beach topography and landform, as shown in Table C.1.

6.1.2.2 Survey frequency

The survey frequency requirements are as follows:
a) Normal survey: twice a year onein summer and the other in winter;
b) Survey during storms: one survey shall be conducted within 15 days after the storm. If there are multiple storms, the last storm shall be used as the starting point of the follow-up survey.

6.1.2.3 Technical requirements

Technical requirements are as follows:
a) The requirements for topographic survey of backshore and foreshore profiles include the following terms:
--The survey scale factor shall not be less than 1:500;
--The accuracy of plane positioning is in the sub-meter level, and the accuracy of elevation is in centimeters.
--Other measurement requirements shall comply with the provisions of Clause 10 of GB/T 17501-2017.
b) The requirements of the inshore profile topographic survey include the following terms:
--The survey scale shall not be smaller than 1:2000;
--The depth measurement accuracy shall be higher than 0.3/(m);--Other measurement requirements shall comply with the provisions of Clause 5 of GB/T 12763.10-2007.

6.1.3 Beach morphology

The distribution of morphology such as berm, erosion scarp, submarine bar, beach cusp, and sand ripples shall be identified along the profile direction, which is carried out simultaneously with the profile topography survey. Filling survey form of beach topography and morphology, as shown in Table C.1.

6.1.4 Sediment

6.1.4.1 Stations layout

The method of station layout is as follows:
a) The sediment survey profile shall be consistent with the topography survey profile, and one surface sediment sampling point shall be set up at each representative location such as dune, berm, high tide zone, middle tide zone, and low tide zone respectively.
b) No less than 3 intertidal zone survey stations shallshall be set if the length of the intertidal zone is shorter than 200m. No less than 5 intertidal zone survey stations shall be set if the length of the intertidal zone is longer than 200/(m).
c) The principle of subaqueous sediment survey station shall be one station every 500/(m).

6.1.4.2 Survey frequency

In accordance with the methods of topography survey

6.1.4.3 Technical requirements

Technical requirements are as follows:
a) The sampling depth shall be 5/(cm)~20/(cm) in the surface layer;
b) Surface samples can be packed in sample bags, and each sample shall beat least 500/(g); Fill in the sediment sample label and sampling station summary table, see Table D.1 and Table D.2;
c) Indoor test analysis of sediment particle size is carried out following the requirements of 6.3 in GB/T 12763.8-2007, and a summary table of particle size analysis results is filled out, as shown in Table D.3;
d) If the substrate is gravel, the long axis, the middle axis, and the short axis of the gravel at the sampling station shall be measured separately, and the morphological parameters shall be calculated according to the requirements in Annex E.

6.1.5 Offshore dynamic environment

Data acquisition for waves, ocean currents, suspended sediments, tide levels, winds, and regional sea level is mainly carried out with data collection. Data time-based effect, survey timing, station layout, and technical requirements are implemented in accordance with provisions of 6.1 in HY/T 255-2018.

6.2 Biocenosis survey

6.2.1 Intertidal benthic organisms

6.2.1.1 Stations layout

The method of stations layout is as follows:
a) Conducting survey on the section with integrated intertidal zone, stable shoreface, and non- or little anthropogenic perturbations;
b) Setting 2 stations in high tidal zone, 3 stations in middle tidal zone and 1 or 2 stations in low tidal zone with the length of intertidal zone longer than 200/(m). Otherwise, setting 1 station in high tidal zone, 3 stations in middle tidal zone and 1 station in low tidal zone.

6.2.1.2 Survey frequency

Once during spring tides in spring and autumn every year.

6.2.1.3 Technical requirements

4 ~8 quadrates are taken from each station with a quantitative frame of 25/(cm)×25/(cm)×30/(cm) for qualitative sampling and observation. When sampling, first

insert the sampler baffle into the groove of the frame, then insert it into the beach, and then observe the visible organisms and quantity on the surface of the recording frame, see Table F.1.

6.2.2 Backshore vegetations

6.2.2.1 Stations layout

The method of stations layout is as follows:
a) Line transect settings
Requirements for transect line settings include:
--The establishment of transect shall take into account of the combination of representativeness, randomness, integrity and accessibility;
--The layout of the transect is as comprehensive as possible, and is distributed in representative sections throughout the survey area to avoid negligence in some areas, and the route is recorded with GPS.
b) Sample positions and quadrat settings
Requirements for sample position and quadrat settings include:
--Quadrat area of tree species and large shrub is 100/(m^2)(10/(m)×10/(m)). The main quadrate is usually set as a square, or a rectangle under special circumstances, but its shortest side shall not be less than 5/(m);
--Quadrat area of suffruticosa plants and tall herb is 25/(m^2)(5/(m)×5/(m));
--Quadrat area of herbaceous plant is 1/(m^2)(1/(m)×1/(m));
--Liana: Total quadrat area of liana growing in high-forest is 100/(m^2)(10/(m)×10/(m)). Quadrat area of liana growing in thicket is 25/(m^2) (5/(m)×5/(m));
--In order to ensure the required accuracy of the survey, the distance between two sample positions shall not be less than 100/(m), and each plant community shall have at least one sample position.

6.2.2.2 Survey frequency

The survey frequency requirements are as follows:
a) Regular survey：Once a year, usually arranged during May to September;
b) Survey during storms：Once within a month after storm.

6.2.2.3 Technical requirements

Technical requirements are as follows:
a) Tree and shrub species with DBH larger than 5/(cm) need to be surveyed. Shrub species and herbaceous species are investigated and recorded in the unit of shrub or plant. The plant resource record form shall be filled in, as shown in Table G.1; Other records may be executed in accordance with Annex B in LY/T 1820-2009;
b) The remote sensing image resolution shall be no less than 0.6m and the mapping scale precision shall be no less than 1:5000 when the backshore vegetation area is acquired through satellite remote sensing image interpretation. The remote sensing image resolution shall be no less than 0.3/(m), and the mapping scale precision shall be no less than 1:3000, when the backshore vegetation area is obtained through UAV remote sensing image interpretation.

6.3 Survey of environmental elements

6.3.1 Nearshore seawater quality

6.3.1.1 Stations layout

The method of stations layout is as follows:

a) The sea water quality monitoring section shall be perpendicular to the main tide direction or the coastline, and the number of monitoring sections is determined according to the length of the beach. Setting no less than 1 monitoring section when beach length is not larger than 2/(km); Setting no less than 2 monitoring sections when beach length is from 2/(km) to 5/(km). Setting no less than 3 monitoring sections when beach length is larger than 5/(km).
b) Total number of monitoring stations on the beach is no less than 3.

6.3.1.2 Survey frequency

Once in winter and summer every year.

6.3.1.3 Technical requirements

Technical requirements are as follows:
a) Sample collection complies with GB 17378.3 standard, and sample depth shall be 30/(cm) below water surface;
b) Analysis of fecal coliform shall comply with Clause 7 of GB 17378.7 standard. Analysis of water color, water temperature, salinity, transparency, PH value, petroleum, dissolved oxygen and suspended materials complies with Clauses 13, 21, 22, 25, 26, 27, 29 and 31 of GB 17378.4-2007 standard.

6.3.2 Sediment quality

6.3.2.1 Stations layout

In accordance with the requirements given in 6.1.4.1

6.3.2.2 Survey frequency

In accordance with the method of water quality survey

6.3.2.3 Technical requirements

Technical requirements are as follows:
a) Sample method complies with Clause 4 of GB 17378.5-2007;b) Analysis of fecal coliform shall comply with GB 17378.7 standard. Analysis of fecal coliform, petroleum, organic carbon and sulfide complies with Clauses 13, 17 and 18 of GB 17378.5-2007.

6.4 Survey of threat factors

The field survey methods of threat factors are shown in Table 2.

Table 2— Field survey methods of threat factors

Contents	Requirements	
Marine disasters	Scopes	Survey zone and adjacent sea zone.
	Contents	Disaster frequency, typhoon disaster level, historical maximum typhoon storm surges, etc.
	Requirements	Collect data on historical marine disasters.
Coastal structures	Scopes	Survey zone and adjacent zone within 2km.
	Contents	Type, construction time and construction location.
	Requirements	Collect data of coastal engineering construction in recent years.
Seawater	Scopes	Survey zone and adjacent sea zone.

pollution	Contents	Type of pollution, scope of pollution, duration of pollution.
	Requirements	Collect current and historical marine pollution data.
Fishing and aquaculture	Scopes	Survey zone and adjacent sea zone.
	Contents	Time, type, region.
	Requirements	Collect current and historical aquaculture data.
Artificial sand mining	Scopes	Survey zone and adjacent sea zone.
	Contents	Sand mining time, sand mining location, sand mining amount, sand mining sediment characteristics.
	Requirements	Collect all artificial sand mining data.
Threats to forest health	Scopes	Backshore
	Contents	Types of disasters (indiscriminate cutting, fire, diseases and insect pests, invasion of exotic plants, etc.), affected area, impact intensity
	Requirements	To collect vegetation disaster data of sandy land in the last 30 years.
Coastal garbage	Scopes	Dry beach, intertidal zone.
	Contents	Density of beach waste.
	Requirements	See Annex H.

7 Ecological status evaluation

7.1 Evaluation index and weight

The status evaluation of sandy coastal ecosystem is carried out quantitatively from three aspects: beach characteristics, biocoenosis and environmental elements. See Table 3 for the specific evaluation indexes and assignment weights.

Table 3— Evaluation index and weight assignment of sandy coast ecological condition

Evaluation contents		Evaluation indexes	Index weight
Beach characteristics	Endowment of beach resources	Width of dry beach	40
		Width of intertidal zone	
		Slope of intertidal zone	
		Sediment type	
		Sediment sorting	
		Beach morphology features	
	Disaster mitigation ability	The length of the coastline	40
		Seaward open degree	
		Relative tide range	
		Coastal erosion intensity	
Biocoenosis	Intertidal	Biomass change rate	10

	benthic organisms		
	Backshore vegetation	Rate of total zonal change	
		Rate of coverage change	
Environmental elements	The water environment	Degree of Nearshore seawater quality	10
	Sediment environment	Quality grade of intertidal sediments	

7.2 Reference systems

Reference system is selected and used in the following ways:
a) Collect historical data of the survey zone, including ecosystem data obtained from routine monitoring, special survey, and literature, and establish a reference system.
b) Reference systems shall adopt data that are representative and reflect changes in the ecosystem.
c) When the entire historical data are available, the historical data shall be used as the reference frame for evaluation.
d) When there is a part of historical data available, some historical data will be used as the reference frame for evaluation, and the missing part of the data will only carry out a descriptive evaluation of the current situation.
e) In the absence of historical data, ecosystem status evaluation shall be carried out only, and the results shall be used as a reference frame for future evaluation.

7.3 Evaluation methods

7.3.1 Beach characteristics

7.3.1.1 Interpretation of evaluation indexes

Beach characteristics evaluation indexes are defined as follows:
a) Endowment of beach resources
The endowment of beach resources includes the following contents:
--Width of dry beach/(m): horizontal distance from backshore dune or seawall frontier to mean spring high tide level.
--Width of intertidal zone/(m): horizontal distance between mean high tide level and mean low tide level in cross-shore direction.
--Slope of intertidal zone/(m): slope between mean high tide level and mean low tide level in cross-shore direction, indicated by “variance in height/in length”.
--Sediment type: particle size of intertidal sediments, according to the provisions of Annex A in GB/T 12763.8-2007;
--Sediment sorting: separation coefficient of intertidal sediments, according to the provisions of 6.3.3 in GB/T 12763.8-2007;
--Beach morphology features: The development characteristics of beach morphology types such as berm, erosion scarp, submarine bar, etc.
b) Disaster mitigation ability
Disaster mitigation ability includes the following contents:
--Coastline length/(km) : Reflects the scale of sandy coast;
--Seaward open degree: openness degree of the coast from sea to land, which is expressed as "coastline length/coastline starting point linear distance";

--Relative tide range: reflects the impact of beach storm response intensity, which can be expressed as follows:

$$RTR = MSR/H_b \quad \cdots\cdots(1)$$

WhereWhere:

RTR relative tide range;

MSR mean spring tide range;

H_b breaker wave height.

--Coastal erosion intensity: assess beach stability in survey zones with historical data. The evaluation of coastal erosion intensity is carried out by using the single factor method, which comprehensively considers the two indexes of monitoring coastline position change rate and coastline erosion and deposition rate. When a certain coastline has both coastline position change and coastline erosion and deposition rate, the principle of "choosing high rather than low" is adopted (see Annex I for the calculation method of coastline erosion rate).

Table 4— Evaluation index for coastal stability

Indexes	Classification					
	Deposition	Stable	Micro erosion	Erosion	Strong erosion	Severe erosion
Change rate of coastline position / ($m \cdot a^{-1}$)	$r \geqslant +0.5$	$-0.5 \leqslant r < +0.5$	$-1 \leqslant r < -0.5$	$-2 \leqslant r < -1$	$-3 \leqslant r < -2$	$r < -3$
Beach erosion rate / ($cm \cdot a^{-1}$)	$s \geqslant +5$	$-5 \leqslant s < +5$	$-10 \leqslant s < -5$	$-30 \leqslant s < -10$	$-50 \leqslant s < -30$	$s < -50$
NOTE "+" means accretion; "-" stands for erosion.						

7.3.1.2 Index assignment

The evaluation index values of beach characteristics are shown in Table 5.

Table 5— Evaluation index and valuation standard of beach characteristics

No.	Indexes	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
1	Width of dry beach (m)	≥70	[40,70)	[20,40)	[10,20)	<10
2	Width of intertidal zone (m)	≥150	[100,150)	[50,100)	[30,50)	<30
3	Slope of intertidal zone	≤1/80	(1/80,1/50]	(1/50,1/30]	(1/30,1/20]	>1/20
4	Sediment type	Fine sand	In the fine sand	Medium sand	Coarse sand	Gravel
5	Sediment sorting	Very good	Good	Medium	Poor	Poor
6	Beach	Developed beach berm and	-	Developed	-	Undevelope

No.	Indexes	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
	morphology features	submarine bar, no erosion scarps		beach berm, no submarine bar		d beach berm and submarine bar, with erosion scarps
Assignment		40	30	20	10	5
7	Coastline length (km)	>3.0	(2.0,3.0]	(1.0,2.0]	(0.5,1.0]	≤0.5
8	Seaward open degree	≥1.5	/	[1.3,1.5)	/	[1,1.3)
9	Relative tide range	≥6	/	[3,6)	/	<3
10	Coastal erosion intensity (coastal stability)	Deposition/stabilization	Micro erosion	The erosion of	Strong erosion	Severe erosion
Assignment		40	30	20	10	5

7.3.1.3 Calculation method

The calculation method of beach feature evaluation index is as follows:

a) Endowment of beach resources

The beach resource endowment index is calculated according to FormulaFormula (2):

$$S_r = \frac{\sum_i^6 R_i}{6} \qquad \text{.....(2)}$$

Where,Where

S_r Index of beach resource endowment;

R_i Assignment of the i^{th} beach endowment evaluation index.

When $5 \leqslant S_r < 10$, the beach resource endowment is general; When $10 \leqslant S_r < 25$, the beach resource endowment is better; When $25 \leqslant S_r \leqslant 40$, the beach resource endowment is good.

b) Disaster mitigation

The calculation of disaster mitigation ability status index is based on Formula (3) :

$$S_d = \frac{\sum_i^4 D_i}{4} \qquad \text{.....(3)}$$

Where,Where

S_d Index of disaster mitigation ability;

D_i Assign the i^{th} disaster mitigation ability evaluation index.

When $5 \leqslant S_d < 10$ the disaster mitigation ability is weak; When $10 \leqslant S_d < 25$, the disaster mitigation ability is general; When $25 \leqslant S_d \leqslant 40$, disaster mitigation ability is strong.

7.3.2 Biocoenosis

7.3.2.1 Index assignment

See Table 6 for the values of biocenosis evaluation indexes

Table 6— Evaluation index and evaluation criteria of biocenosis

No.	Indexes	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
1	Change rate of benthic biomass in intertidal zone	≥5%	[0, 5%)	[-5%, 0)	[-10%, -5%)	<-10%
2	Rate of change of total zone of backshore vegetation	≥10%	[5%, 10%)	[0, 5%)	[-10%, 0)	<-10%
3	Rate of change of coverage of backshore vegetation	≥10%	[5%, 10%)	[0, 5%)	[-10%, 0)	<-10%
Assignment		10	8	6	4	2

7.3.2.2 Calculation

The evaluation index of biocenosis is calculated as follows:

a) Change rate of benthic biomass in intertidal zones

The index value of intertidal benthic biomass is calculated according to FormulaFormula (4):

$$\bar{T} = \frac{\sum_i^N T_i}{N} \quad \cdots\cdots (4)$$

Where: T Mean value of intertidal benthic biomass monitored;

T_i the i^{th} quadrat value;

N Total number of quadrats in the evaluation zone.

The assignment of the above indexes is calculated according to Formula (5):

$$B_1 = \frac{T_0 - \bar{T}}{T_0} \times 100\% \quad \cdots\cdots (5)$$

Where:

B_1 The index change rate of intertidal benthic biomass;

T Mean value of intertidal benthic biomass monitored;

T_0 Data in the reference system or reference data.

b) Rate of change of total zone of backshore vegetation

The change rate of the total zone of the backshore vegetation is calculated according to Formula (6):

$$B_2 = \frac{A_0 - A}{A_0} \times 100\% \quad \cdots\cdots (6)$$

Where:

B_2 Rate of change of total zone of backshore vegetation;

A Measured value of the total zone of backshore vegetation, in ha;

A_0 Data in the reference system or reference data.

c) Change rate of vegetation coverage on the backshore

The change rate of vegetation coverage on the backshore is calculated according to Formula (7):

$$B_3 = \frac{C_0 - C}{C_0} \times 100\% \quad \cdots\cdots (7)$$

Where:
B_3 Change rate of vegetation coverage on the backshore;
C Measured value of backshore vegetation coverage;
C_0 Data in the reference system or reference data.
d) Biocenosis status index
The calculation of biocenosis status index is shown in Formula (8):

$$B = \frac{\sum_i^3 B_i}{3} \quad \cdots\cdots (8)$$

Where:
B Biocenosis status index;
B_i Assign the i^{th} biocoenosis evaluation index;
When $2 \leqslant B < 5$, the biocenosis is severely damaged. When $5 \leqslant B < 7$, the biocenosis is damaged. When $7 \leqslant B < 10$, the biocenosis is stable.

7.3.3 Environmental elements

7.3.3.1 Index assignment

The evaluation index values of environmental elements are shown in Table 7.

Table 7— Environmental factor evaluation indexes and evaluation criteria

No	Indexes	Ⅰ	Ⅱ	Ⅲ
1	Grade of Nearshore seawater quality	Category 1	Category 2 / Category 3	Category 4
2	Quality grade of intertidal sediments	Category 1	Category 2	Category 3
Assignment		10	6	2

7.3.3.2 Calculation method

The evaluation index of environmental elements is calculated as follows:
a) Obtain nearshore seawater quality levels and intertidal sediment quality levels as required by 6.3.
b) The calculation of environmental status index is shown in Formula (9):

$$E = \frac{\sum_i^2 E_i}{2} \quad \cdots\cdots (9)$$

Where:
E Environmental status index;
E_i Assign the i^{th} environmental status evaluation index.
When $2 < E \leqslant 5$, the environmental condition index is not suitable. When $5 < E \leqslant 7$, the environmental condition index is moderately suitable. When $7 < E \leqslant 10$, the environmental condition index is suitable.

7.3.4 Comprehensive evaluation

The comprehensive evaluation of the ecological status of sandy coast is shown in Formula (10):

$$I_{sc} = S_r + S_d + B + E \quad \cdots\cdots (10)$$

Where:
I_{sc} Comprehensive index of the status of sandy coastal ecosystems;
S_r Index of beach resource endowment;
S_d Index of disaster mitigation ability;
B Biocenosis condition index;

E Environmental status index.

When $I_{sc} > 64$, sandy coast ecosystem status is stable, which is classified into class Ⅰ; When $30 < I_{sc} \leqslant 64$, sandy coast ecosystem status is damaged, evaluation level for Ⅱ; When $I_{sc} \leqslant 30$, sandy coast ecosystem status is severely damaged, evaluation level for Ⅲ.

In the survey results report, the internal causes and external drivers of the changes in the ecological status of sandy coasts are comprehensively analyzed and corresponding management measures are proposed based on the results of the comprehensive evaluation of the ecological status of sandy coasts and the threat factors that are not included in the quantitative evaluation above

Table 8—. Classification and management measures of sandy coastal ecosystem status evaluation results

Classification	Classification description	Management measures
Ⅰ	The sandy coastal ecosystem is stable, the beach profile topography and layout are in a state of dynamic equilibrium, and the biocenosis, water environment and sedimentary environment are good and self-sustaining	Continuous follow-up monitoring and scientific management
Ⅱ	The sandy coastal ecosystem is damaged, coastal erosion occurs, and the biocenosis, water environment and sedimentary environment are damaged, which can maintain the basic structure and self-recovery ability	Strengthen ecological management, control threat factors, promote the natural rehabilitation of sandy coastal ecosystems
Ⅲ	The sandy coastal ecosystem is severely damaged, the coastal erosion is serious, the biocenosis, the water environment and the sedimentary environment are seriously damaged, and it is difficult to maintain the basic characteristics and self-recovery capacity of the beach	Ecological management shall be strengthened to control the threat factors, and artificial rehabilitation measures shall be taken to improve the ecosystem status

Annex A
(annex normative)
Outline of a survey and evaluation report on the status of sandy coastal ecosystems

A.1 Text format

A.1.1 Text specifications

The external dimension of the text is A4 (210/(mm)×297/(mm)).

A.1.2 Cover format

Line 1: ×× Ecosystem (No. 1 Song typeface, bold, centered);
Line 2: The status quo Investigation and Evaluation report (No. 1 Song typeface, bold, centered);
Line 3: full name of the report compilation unit (No. 3 Song typeface, bold, in the middle);
Line 4: xx-month xxx year (small three Song typeface size, bold, center);
The above line spacing shall be appropriate to keep the entire cover beautiful.

A.1.3 Contents in the envelope

In the envelope, the branch shall indicate: full name of the company compiling the status investigation and evaluation report (with official seal); The name of the compiler and auditor, etc.

A.2 Outline for the preparation of A report on the status survey and Evaluation of sandy coastal ecosystems

According to Table A.1, A survey and evaluation report on the status quo of sandy coastal ecosystems is prepared. The relevant Clauses can be added or subtracted appropriately according to the characteristics of the investigation area and the investigation content.

Table A.1— Outline for the preparation of A report on the status survey and Evaluation of sandy coastal ecosystems

1 overview
1.1 Task Source
1.2 Purpose and Significance
1.3 Scope of investigation and evaluation
1.4 Technical methods of investigation and evaluation (including the arrangement of survey stations, survey time, scale, coordinate system, elevation system, instruments, equipment and personnel, etc.)
2. Survey area conditions
2.1 Hydrological dynamics
2.2 Topography, landform and scour and silt environment
2.3 Coastal evolution characteristics
2.4 Marine Disasters
2.5 Marine ecological environment

Table A.1— Outline for the preparation of A report on the status survey and Evaluation of sandy coastal ecosystems (Continue)

3 Survey results on the status quo of sandy coastal ecosystems
3.1 Preliminary remote sensing Identification (describing the distribution and scale of sandy coasts)
3.2 Survey results of beach features
3.2.1 Results of coastline survey (indicating the location and length of coastline, as well as erosion, depoisiton or stabilization of coastline location, distribution and length)
3.2.2 Results of profile topography survey (draw the beach profile topography map as required by Figure C.1 in Annex C. The information such as profile number, direction and elevation datum shall be indicated, and the regional positions of various landforms shall be marked on the profile; Explain the profile shape and the state of beach erosion and silting).
3.2.3 Results of sediment survey (indicating characteristics of sediment particle size parameters and sediments at the same station, particle size parameter variation)
3.3 Biocenosis survey (explaining dominant species of intertidal benthic organisms, dominant species of backshore vegetation and native species)
3.4 Survey of environmental elements
3.5 Survey of threat factors
4 Ecosystem evaluation
4.1 Selection of reference system
4.2 Beach characteristics
4.3 Biocenosis evaluation
4.4 Analysis of changing characteristics of environmental elements
4.5 Damage analysis (including natural factors and human factors)
5 Conclusions and suggestions (explain the evaluation levels and comprehensive evaluation levels of the sandy coast ecosystem, analyze the future development trend of the sandy coast ecosystem, and put forward management countermeasures and suggestions)

Annex B
(annex informative)
Schematic diagram of typical sandy coast profile

Fig. B.1 shows a schematic diagram of a typical sandy coast profile.

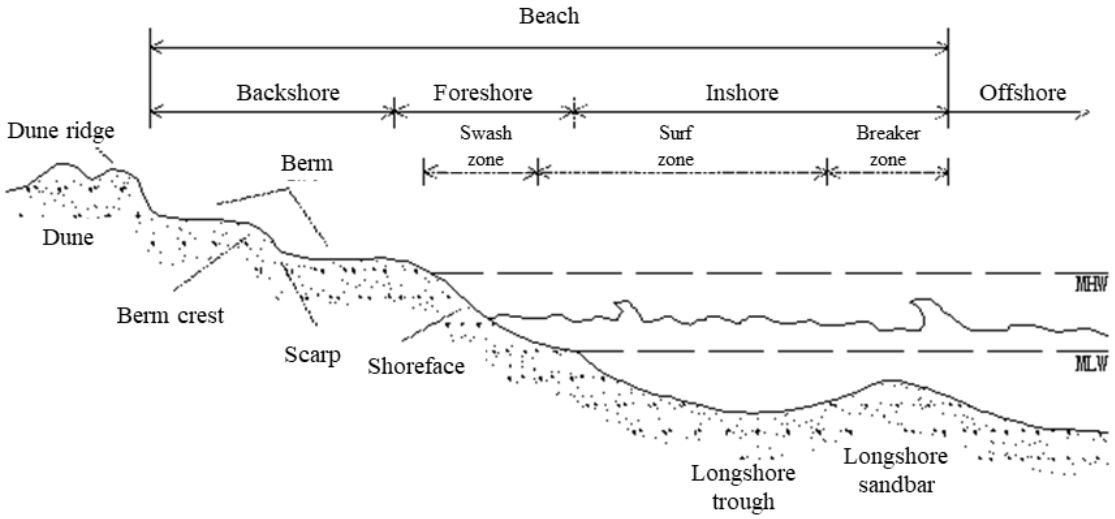

Fig B.1 Schematic diagram of a typical sandy coast profile

Annex C
(annex normative)
Beach topography survey chart

Table C.1 gives the investigation form of beach topography. Fig. C.1 shows the topography of the beach profile.

Table C.1— Survey table on beach topography

Profile name							
Location		Time			Profile ID		Topography types
Instruments					Batches		
Profile origin (coordinate system)			Elevation base	Direction	Length	Measurement points	
Number of points	X		Y		Z	Number of samples	
Instruments		Sample		Check		Record		
				Affiliation			

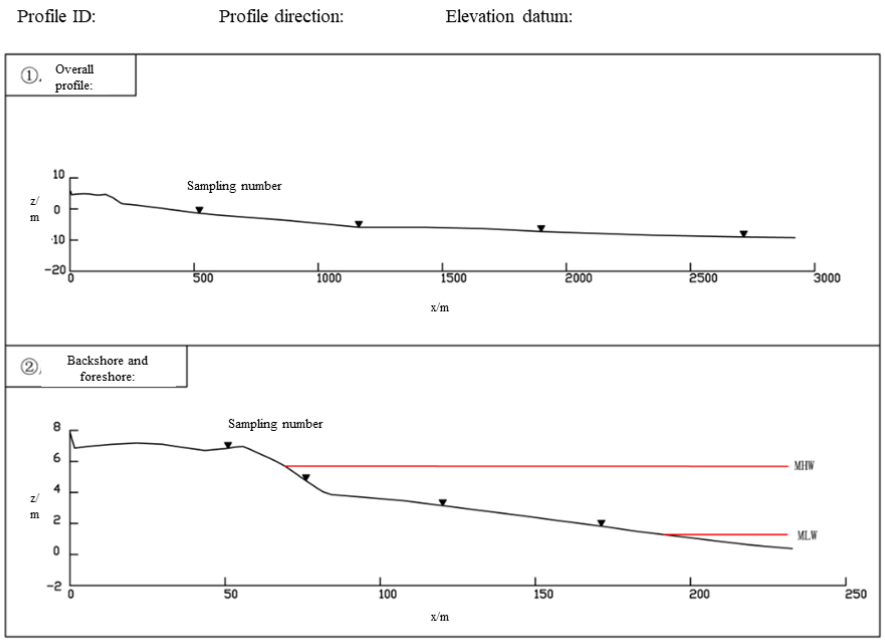

Fig. C.1 Topography of beach profile

Annex D
(annex normative)
Sediment inventory

Table D.1 shows the labels of sediment samples, Table D.2 shows the summary table of sampling stations, and Table D.3 shows the summary table of grain size analysis results.

Table D.1— Labels of sediment samples

Survey area	Province (district, city) City District (county)
Name of the coast	
Profile number	
Sample number	
Sampling time	Year Month Day
The sampling person	

Table D.2— Summary table of sampling stations

Sample number	North latitude	East longitude	Name

Lister: Auditor:

Table D.3— Summary of grain size analysis results

Coastal name: Province (district, city) City District (county)

Investigation unit: Investigator: Investigation time: Page ID: , Total Pages:

No.	Station No.	Sequence	Gravel (mm)	Sand (mm)						Silty sand (mm)				Clay (mm)		Graded levels					Code name	Particle size coefficient			
			>4	4 to2	2 to1	1 to0.5	0.5 to0.25	0.25 to0.125	0.125 to0.063	0.063 to0.032	0.032 to0.016	0.016 to0.008	0.008 to0.004	0.004 to0.002	0.002 to0.001	<0.001	gravel	sand	silt	clay		Mzφ	σiφ	Skiφ	Kgφ

Analysis: Processing: Check:

Annex E
(annex informative)
Gravel shape parameter calculation method

The shape parameters of gravel include Sphericity MPS (Maximum height Sphericity), oblate-prolate Index (Oblate-Prolate Index), disc-rod Index (DRI) and roundness (Rn), which are calculated as:

$$MPS = \frac{A+B+C}{3A} \quad \text{.....(E.1)}$$

$$OPI = \frac{10\left[(A-B)/(A-C)-0.5\right]}{(C/A)} \quad \text{.....(E.2)}$$

$$DRI = \frac{A-B}{A-C} \quad \text{.....(E.3)}$$

Where:

MPS Sphericity;

OPI Flat length index;

DRI Disk-rod index;

A Length of long axis in centimeters/(cm);

B Length of the central axis in centimeters/(cm);

C Length of the short axis in centimeters/(cm).

The abrasive roundness (Rn) of the gravel was determined by visual measurement, which was divided into six levels: pointy angular VA, angular V, subangular SA, subcircular SR, rounded R, and rounded WR.

Annex F
(annex normative)
Intertidal biometric record sheet

Table F.1 shows the biometric records of intertidal zone.

Table F.1— Biometric records of intertidal zone

The Page, Including Pages

Location: Province (district, city) City District (county)

Coast name: Station No. : Quadrat No. :

Substrate type:: Sampling area: m^2 Sample thickness: cm

Sampling date: Year Month Day

No.	Kind of name	Number	Note
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Gatherers Filler Reckoner Proofreader

Annex G
(annex normative)
Questionnaire for backshore Vegetation

Table G.1 gives the questionnaire of backshore vegetation.

Table G.1— Questionnaire for backshore vegetation

Location: Province (district, city) City District (county)
Investigation Unit: Investigator: Investigation time The Page, Including Pages

No.	Kind of name	Dominant species or not (" √ ")	Whether cultivated or not (" √ ")	Biotype	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Annex H
(annex informative)
Beach waste monitoring methods

Beach waste monitoring indicators include accumulation rates and persistent stocks. It is advisable to monitor the accumulation rate of the beaches that are cleaned regularly. Continuous stock monitoring shall be carried out on beaches where small pieces of rubbish are difficult to clean.

(1) When monitoring the accumulation rate, the sampling unit shall be a monitoring section or the whole beach randomly arranged on the beach, so as to evaluate the variation of the total amount of garbage on the beach over time in the monitoring area. All visible garbage in the sampling unit shall be cleaned up before sampling (excluding garbage buried in the beach).

(2) For continuous stock monitoring, the sampling unit is a monitoring section randomly arranged on the beach to evaluate the total amount of garbage on the beach in the monitoring area at a certain time point. Visible garbage in the sampling unit shall not be cleaned before sampling begins.

The width of the monitoring section is 5m and the length is from the water edge to the mean high water line or the vegetation-covered area. Monitoring personnel work in pairs, one person collects and handles garbage, and the other records data. No sampling is conducted for large or extra-large pieces of garbage and small pieces of garbage below 6mm. Garbage collected on the beach shall be removed after statistical classification and weighing.

Beach waste density (D) (x /km)^2 Or kg/km^2) is calculated as follows:

$$D=n/Lw \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (H.1)$$

Where:

W Width of the monitored section, in kilometers/(km);

L The total length of the monitored section, in kilometers/(km);

N The total amount or weight of garbage in units or kilograms/(kg).

Annex I
(annex informative)
Coastal erosion rate calculation method

I.1 Calculation method for the change rate of coastline position

It is recommended to use the Digital Shoreline Analysis System of the US to calculate the rate of coastline change.

a) End Point Rate (EPR)

The endpoint method uses only 2 historical location data to calculate the coastline position change rate (EPR), whose mathematical expression is:

$$EPR = \frac{D_1 - D_2}{T_1 - T_2} \qquad \text{.....(I.1)}$$

Where:

D_1 and D_2 is time T_1 and T_2 When the coastline position.

b) Linear Regression, LR

The linear regression method is to obtain a univariable linear optimal trend line corresponding to all data according to the least square method. The slope of this line is the change rate of shoreline position, and its root-mean-square difference can reflect the dispersion of data.

$$y = a_0 + b_0 x \qquad \text{.....(I.2)}$$

$$\text{即} \quad \begin{bmatrix} m & \sum x_i \\ \sum x_i & \sum x_i^2 \end{bmatrix} \begin{bmatrix} a_0 \\ b_0 \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum x_i y_i \end{bmatrix}$$

Where:

b_0 Change rate of coastline position;

x_i, y_i Coastline position of group I data.

I.2 Calculation method of beach erosion and deposition rate

When calculating the beach erosion and accretion rate, the vertical line shall be drawn downward, the intersection positions of the perpendicular line and the terrain profile line in different periods shall be read respectively, and then the beach erosion and accretion rate shall be calculated.

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