

Regional difference in distribution pattern and morphological characteristics of embayed sandy beaches in Zhejiang province, eastern China

Junli Guo^{1,2}, Lianqiang Shi^{1,2*}, Min Zhang¹, Zhaohui Gong¹, Wei Chen³, Xiaoming Xia^{1,2*}

¹Second Institute of Oceanography, MNR, Hangzhou 310012, China; guojl@sio.org.cn;

lqshi@sio.org.cn; cheungminn@163.com; 13433279480@163.com; xiaxm@sio.org.cn

²Key Laboratory of Ocean Space Resource Management Technology, MNR, Hangzhou

310012, China; guojl@sio.org.cn; lqshi@sio.org.cn; cheungminn@163.com;

13433279480@163.com; xiaxm@sio.org.cn

³Institute of Coastal System-Analysis and Modeling, Helmholtz-Zentrum Hereon, Geesthacht

21502, Germany; wei.chen@hereon.de

*Correspondence: lqshi@sio.org.cn; xiaxm@sio.org.cn

The supplementary materials include Table S1-S4 and Figure S1. Table S1 shows the location, measurement information, and the human intervention information of the studied beaches. Table S2, S3, and S4 show the principal component eigenvalues, variance contribution rates and cumulative contribution rates of sandy beach in northern Zhejiang (NZ), central Zhejiang (CZ), and southern Zhejiang (SZ), respectively. NZ1 in the Table S2, CZ1 in Table S3, and SZ1 in Table S4 represent the first principal component in NZ, CZ, SZ beaches, respectively. Figure S1 shows the profile and sampling site setting examples for beaches with different length and the calculation of beach slope and the dry beach width.

Table S1. Location, measurement information, and the human intervention information of the studied beaches

ID	Beach	Location	Island beach	Measurement date	Profile number	Sample number	Seawall	Breakwater	Beach nourishment	Drainage output
1	Nanwan	NZ	YES	2020/7/18	1	3	√			
2	Jinshacun	NZ	YES	2020/7/16	1	3	√			
3	Si'ao	NZ	YES	2020/7/17	1	3	√			
4	Wusha	NZ	YES	2020/7/17	1	3	√			
5	Miaogan	NZ	YES	2020/7/17	1	3	√	√		
6	Dawangcun	NZ	YES	2020/7/17	2	6	√			
7	Longquan	NZ	YES	2020/7/17	2	6	√			
8	Huangsha'aocun	NZ	YES	2020/7/15	1	3	√			
9	Dahuangsha	NZ	YES	2020/7/15	3	9	√			
10	Shizhu	NZ	YES	2020/7/16	1	3				
11	Zhongdongjiao	NZ	YES	2020/7/12	1	3	√	√		
12	Xichangsha	NZ	YES	2020/7/12	2	6	√	√		
13	Changyin	NZ	YES	2020/7/12	1	3				
14	Waishanzui	NZ	YES	2020/7/12	1	3				
15	Zhoushanchangsha	NZ	YES	2020/7/12	1	3	√	√		
16	Tongpanwan	NZ	YES	2020/7/10	1	3				
17	Maojia'ao	NZ	YES	2020/7/10	2	6				
18	Hou'aosha	NZ	YES	2020/7/3	1	3	√	√		
19	Baotuo	NZ	YES	2020/7/3	2	6	√			
20	Feisha'ao	NZ	YES	2020/7/8	1	3				

21	Huanxiling	NZ	YES	2020/7/3	1	3				
22	Qianbusha	NZ	YES	2020/7/3	3	9				
23	Baibusha	NZ	YES	2020/7/8	3	9				
24	Dashali	NZ	YES	2020/7/9	3	9	√			
25	Dongsha	NZ	YES	2020/7/2	3	9	√		√	√
26	Qiansha	NZ	YES	2020/7/2	3	9				
27	Tawanjinsha	NZ	YES	2020/8/28	3	9				√
28	Changbing	NZ	YES	2020/8/27	1	3	√			
29	Cha'ao	NZ	YES	2020/8/27	1	3				
30	Yangshashan	NZ	NO	2020/8/22	2	6	√			
31	Xiahuangsha	NZ	YES	2020/8/24	1	3	√			
32	Henicao	NZ	YES	2020/8/24	1	3	√			
33	Huangsha	NZ	YES	2020/8/23	1	3		√		
34	Changshayucun	CZ	NO	2020/8/21	3	9		√		
35	Xiasha	CZ	NO	2020/8/20	3	9	√			
36	Ningbo Da'ao	CZ	NO	2020/8/20	3	9				
37	Xiaowanjiao	CZ	NO	2020/8/21	1	3				
38	Baishawan	CZ	NO	2020/8/21	3	9	√		√	√
39	Songlanshanbei	CZ	NO	2020/8/21	1	3				
40	Pingyanjiao	CZ	NO	2020/8/21	2	6	√			
41	Songlanshandong	CZ	NO	2020/8/21	3	9	√			
42	Slonglanshannan	CZ	NO	2020/8/21	3	9	√			
43	Dongdan	CZ	NO	2020/8/20	3	9				
44	Jiaolong	CZ	NO	2020/8/20	3	9				
45	Hetou	CZ	NO	2020/8/20	3	9	√		√	
46	Huangcheng	CZ	NO	2020/8/18	3	9	√		√	

47	Tantoushan	CZ	YES	2020/8/19	3	9	√	
48	Xiawanmen	CZ	YES	2020/8/18	2	6		
49	Dashacun	CZ	YES	2020/8/18	3	9		
50	Hutoushanzui	CZ	NO	2020/8/16	1	3	√	
51	Hua'ao	CZ	YES	2020/8/17	3	9	√	√
52	Mushao	CZ	NO	2020/8/16	2	6	√	
53	Niuweitang	CZ	NO	2020/8/16	3	9		
54	Longwan	CZ	NO	2020/8/11	1	3		
55	Nanmenkeng	CZ	NO	2020/8/11	2	6		
56	Longmen	CZ	NO	2020/8/11	2	6		
57	Cheguanjin	CZ	NO	2020/8/10	3	9	√	
58	Baima'ao	CZ	NO	2020/8/8	2	6	√	√
59	Guanyinjiaoyueliang	SZ	YES	2020/8/8	2	6	√	
60	Wenzhou Da'ao	SZ	YES	2020/8/7	1	3		
61	Guanteng'ao	SZ	YES	2020/8/7	1	3		
62	Aoditan	SZ	YES	2020/8/7	2	6	√	
63	Longtoujin	SZ	YES	2020/8/6	2	6		
64	Dong'ao	SZ	YES	2020/8/6	1	3	√	√
65	Sha'ao	SZ	YES	2020/8/5	1	3	√	√
66	Banping	SZ	YES	2020/8/6	1	3	√	√
67	Xishuai	SZ	YES	2020/8/6	1	3		
68	Yanting	SZ	NO	2020/8/30	3	9	√	√
69	Haikou	SZ	NO	2020/8/30	2	6	√	
70	Wuchengyueliangwan	SZ	NO	2020/8/2	3	9	√	
71	Yuliaojin	SZ	NO	2020/8/2	3	9	√	
72	Houcao	SZ	NO	2020/8/2	3	9	√	

73	Peilei	SZ	NO	2020/8/2	2	6	√
74	Wenzhou Changsha	SZ	NO	2020/8/1	3	9	
75	Guixin'ao	SZ	NO	2020/8/1	2	6	

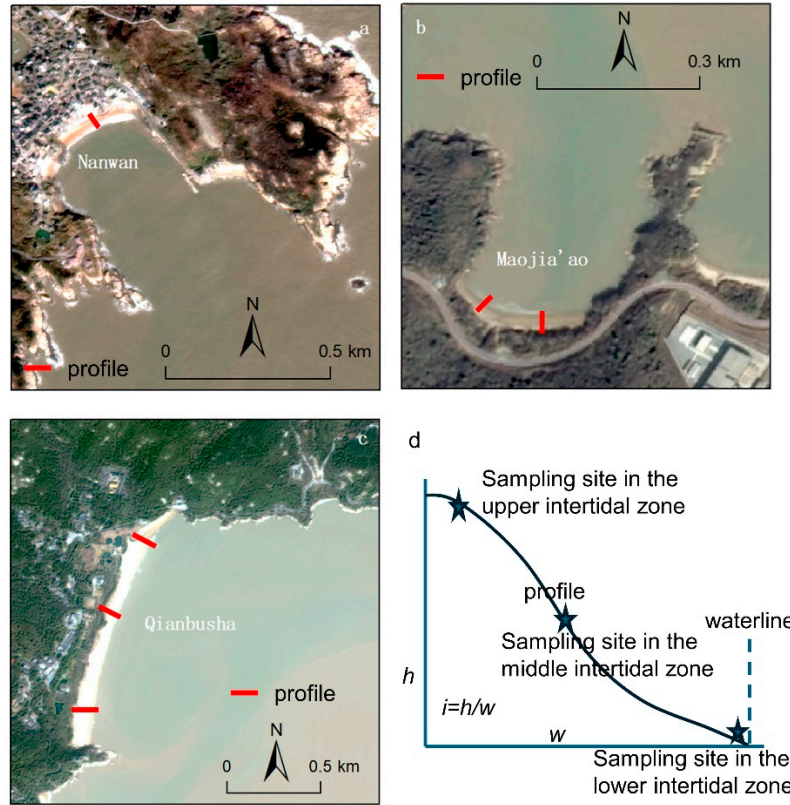


Figure S1. Examples of profile settings on the beach with different lengths (a-c) and the sampling sites (d): Nanwan beach (<300 m) (a), Maojia'ao beach(300 m-500 m) (b), and Qianbusha beach (>500 m). h is the maximum height of the profile, w is the dry beach width, and i is the beach slope. The average slopes and the grain size characteristic values shown in the main text are the arithmetic average values calculated from all the profiles and samples on each beach.

Table S2. The principal component eigenvalues, variance contribution rates and cumulative contribution rates of sandy beach in NZ

PC	Eigenvalue	Variance contribution rate	Accumulated variance contribution rate
NZ1	3.716	33.784	33.784
NZ2	1.931	17.554	51.338
NZ3	1.325	12.044	63.382
NZ4	1.054	9.585	72.967
NZ5	0.940	8.544	81.511
NZ6	0.776	7.056	88.567
NZ7	0.678	6.163	94.730
NZ8	0.257	2.336	97.066
NZ9	0.206	1.874	98.940
NZ10	0.093	0.845	99.785
NZ11	0.024	0.215	100.000

Table S3. The principal component eigenvalues, variance contribution rates and cumulative contribution rates of sandy beach in CZ

PC	Eigenvalue	Variance contribution rate	Accumulated variance contribution rate
CZ1	3.515	31.952	31.952
CZ2	1.844	16.763	48.715
CZ3	1.745	15.867	64.582
CZ4	1.487	13.521	78.103
CZ5	0.808	7.347	85.450
CZ6	0.675	6.137	91.587
CZ7	0.352	3.198	94.785
CZ8	0.319	2.904	97.689
CZ9	0.136	1.232	98.921
CZ10	0.101	0.918	99.839
CZ11	0.018	0.161	100.000

Table S4. The principal component eigenvalues, variance contribution rates and cumulative contribution rates of sandy beach in SZ

PC	Eigenvalue	Variance contribution rate (%)	Accumulated variance contribution rate (%)
SZ1	2.943	26.753	26.753
SZ2	2.345	21.319	48.072
SZ3	1.497	13.610	61.682
SZ4	1.243	11.297	72.980
SZ5	1.018	9.255	82.234
SZ6	0.689	6.267	88.502
SZ7	0.492	4.473	92.975
SZ8	0.358	3.251	96.226
SZ9	0.259	2.352	98.578
SZ10	0.145	1.319	99.897
SZ11	0.011	0.103	100.000