Seasonal changes in coastal dynamics and morphological behavior of the central and southern Changjiang River delta

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Abstract  Seasonal changes in sea level, tidal range, wind, riverine discharges, nearshore SSC (suspended sediment concentration) and bed-level of intertidal flat at 4 different sites were shown. In addition, the statistical relationships between the dynamics and the behavior of the sediment surface were examined. The average intertidal elevation seems negatively correlated to sea level while positively correlated to nearshore SSC. The effect of wind on seasonal cycle of average intertidal elevation is not evident although wind is an important factor governing short-term erosion/accretion events. The influence of riverine discharges on seasonal cycle of deltaic intertidal flats is masked by other factors. It is concluded that seasonality on mudflats is more complicated than on beaches.

Keywords: intertidal flat, geomorphology, hydrodynamics, sedimentation, Changjiang River delta.

Seasonal cycles of coastal erosion and accretion have been studied by many authors[1—10]. Beach cycles are usually attributed to winds[1—3]. Whether this is true in muddy coasts has seldom been studied. There are fundamental differences in the behavior of cohesionless and cohesive sediments[11]. Tides are relatively more important on mudflats than on beaches. Therefore it is necessary to take into account more factors, besides wind, in examining the seasonal variation of muddy coasts.

The intertidal sediment of the Changjiang River delta is dominated by silt and clay[12]. The wind, sea level, river-born discharges and longshore currents at the mouth of the river are all seasonally changed because of the influence of the Eastern Asian monsoon. A good positive correlation exists between the wave height and the wind speed as well as between the wave and wind directions in the exposed coasts of this delta[13]. Tidal range and suspended sediment concentration (SSC) also show a seasonal cycle. These hydrodynamic and sedimentary processes may affect changes in the intertidal sediment surface, although they may not be equally important. So, it is meaningful to investigate their seasonal changes and relate them to the variation of sediment surface. The purpose of this paper is to reveal the seasonal changes in multiple factors and to find their relation to the morphological behavior of a muddy coast.

1 Study area

Four transects, A, B, C and D (fig. 1) in the front area of the central (A and B) and southern (C and D) Changjiang River delta were selected for this study. They are different in geomorphic,
dynamic and sedimentary features (table 1).

<table>
<thead>
<tr>
<th>Transect</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean tidal range/m</td>
<td>2.7</td>
<td>2.6</td>
<td>3.4</td>
<td>4.1</td>
</tr>
<tr>
<td>Average of median grain-size ($\Phi_{50}$)</td>
<td>6.2</td>
<td>5.4</td>
<td>5.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Width of intertidal zone/km</td>
<td>3.8</td>
<td>7.5</td>
<td>2.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Vertical accretion rate/cm $\cdot$ a$^{-1}$</td>
<td>4.3</td>
<td>32</td>
<td>-1</td>
<td>2</td>
</tr>
</tbody>
</table>

2 Methods and materials

Data of water and sediment discharges were collected from the Datong Hydrologic Station which is representative of the river’s runoff to the sea. In view of the 700 km distance between the station and the river mouth, a duration from half a month (in the flood season) to a month (in the dry season) was estimated for the water to reach the studied coast in relating the riverine discharges to the variation in bed-level of the coast (e.g. the July discharge at the Datong Station was treated as the August discharge received by the coast). Data of wind, sea level, tidal range and SSC were obtained from the climatological and hydrologic stations which are nearest to the studied transects (fig. 1). The winds were separated into onshore ones and offshore ones according to the relation of their directions to the shoreline trend. Onshore (offshore) wind index was defined as the product of its frequency and mean velocity. The tidal flat elevation is the average of different sites in the transects (Stake method was utilized at site intervals of 200 m in transect B and 100 m in the other three transects).

In order to highlight the seasonal cycle of accretion/erosion, the annual net change in elevation was taken off. Excel and statistic softwares were utilized in processing the data.

3 Results

3.1 Seasonal changes in coastal processes

3.1.1 Riverine discharges. Both of the riverine water and sediment discharges are highest in the summer and lowest in the winter. The maximum water discharge in July is 4.4 times that of the minimum water discharge in January while the maximum sediment discharge in August is 31 times that of the minimum sediment discharge in February.

3.1.2 Dynamic processes. The variation of sea level (fig. 2), tidal range (fig. 3) and onshore (offshore) wind frequency (fig. 4) shows a regular seasonal pattern, while the wind speed is