UNDERWATER BARRED BEACH PROFILE TRANSFORMATION UNDER DIFFERENT WAVES CONDITIONS

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**Study site:** Shkorpilovtsy (Bulgaria)

**Toolkit:**
- xBeach modelling (hydrostatic mode)
- MIKE21 (for waves transformation analysis only)
Computation grid: based on 12 profiles of bathymetry survey on 27th of Sep 2007 (international experiment “Shkorpilovtsy-2007”)

12 Waves regimes:
- Period of spectral peak (Tp) = 7.5 and 10.5 s
- Significant wave height (Hs) = 1.0 and 1.5 s
- Angle of wave energy spreading (s) = 5°, 15°, 25°

Wave input: JONSWAP ($\gamma = 3.3$)
- Model storm duration = 10 hours
**Spatial view of bottom deformation**

- **H=1.0 m, Tp=7.5 s, t=10 h**
  - S=5°
  - S=15°
  - S=25°

- **H=1.5 m, Tp=10.5 s, t=10 h**
  - S=5°
  - S=15°
  - S=25°

- Note: The images show changes in depth (m) and spatial distribution (m) with varying angles (S).
Shoreline regression

Red line: $H=1.0$ m $T_p=7.5$ s
Black line: $H=1.5$ m $T_p=7.5$ s
Green line: $H=1.0$ m $T_p=10.5$ s
Blue line: $H=1.5$ m $T_p=10.5$ s
Profiles deformation analysis

Maximal shoreline erosion ≈ profile A

★ ★ ★ wave data output from Mike21
A

Pier

B

erosion in upper part

accretion in lower part

bar erosion

Depth, m

Distance, m

Distance, m

Distance, m

Depth, m

Depth, m

Depth, m

Distance, m

Distance, m

Distance, m

H=1.0 Tp=7.5 D=280 S=5

H=1.5 Tp=10.5 D=280 S=5

H=1.5 Tp=10.5 D=280 S=5

Depth, m

Distance, m

Distance, m

Distance, m

Distance, m

Distance, m
Waves transformation along profiles

Profile A

Periodical energy exchange between main and highest harmonics

Profile Pier

Profile B
Waves transformation along profiles A, B, Pier

\[
H_S = 4 \cdot \sqrt{m_0}
\]

\[
m_0 = \int_{0}^{\infty} S(\omega) d\omega
\]

\[
T_m = \frac{\int S d\omega}{\int S f d\omega} = \frac{m_0}{m_1}
\]

IGW

GW

Mean wave period, s

Distance from shore, m

Distance from shore, m

Tp=10.5 s

H=1.0 m

S=5°
Wave breaking on profiles

Breaking slightly eliminated advance of IGW due to energy exchange between low- and high-frequency harmonics, as well as IGW dissipation.

\[ T_p = 10.5 \, \text{s} \]
\[ H = 1.0 \, \text{m} \]
\[ S = 5^\circ \]
Results

• At increasing of significant height of a wave, the period and reduction of angle of wave energy spreading there is an increase in deformation of a bottom profile.

• The form and location of underwater terraced structure, which is formed under the influence of waves, depend on significant height and the period of waves.

• The period of spectral peak more influences on the speed of degradation of the coastline than significant wave height.

• Active impact of waves on deeper parts of an underwater profile begins at preservation of the same wave conditions more than 3 hours.

• There is heterogeneity of change of a bottom profile in the northern and southern directions which is caused by the features of transformation of irregular waves over this bottom profile leading to non-uniform variability of a field of infragravity waves.