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The influence of the sea bottom on water wave patterns in satellite photographs

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During our study of the sea bottom near the coast of the Bulgarian Black Sea close to Sozopol, we commissioned Geospace AG, Salzburg, to take satellite photographs at the same site but at different times. Pictures made under strong east wind conditions show patterns at the water surface, which are correlated with distinctive unevennesses in the sea bottom. This effect was investigated qualitatively by a two-dimensional mathematical model featuring an oblique incident water wave travelling over a rectangular step placed in the sea bottom [1].

Within the framework of this step-model, several effects of this bottom-to-surface-mapping (BTSM) process were not explainable. For example, comparison of the patterns with topologic measurements of the bottom showed that their location are not congruent but shifted and scaled depending on the wind direction with respect to the bottom discontinuities. Guided by this fact, we extended this model to the analysis of waves travelling over a ramp on the sea bottom. The governing partial differential equations for sea waves were solved using a multiterm Galerkin approach yielding to the general amplitude distribution of the water waves at the sea surface. Consequentially, it can be showed that the BTSM is strictly related to the appearance of evanescent waves in lateral (to the sea surface) direction above the scattering obstacle because they also cause propagating waves perpendicular to the surface. These waves perpendicular to the resting sea level are reflected on the ramp and result in a shifted and scaled BTSM at the sea surface. Under special circumstances, e.g., high wind strengths and wind directions near the so-called critical angle of the scattering process, the reflection coefficient and the evanescent wave amplitudes can be huge resulting in a good BTSM even for larger water depths.

We verified these theoretical results of water wave patterns in satellite photographs under wind influence in the Bay of Sozopol and in the Central Bay of Sozopol.

The geomorphological study of the sea bottom of the Central Bay of Sozopol shows an old Mesozoic volcanic crater and its volcanic stream into the sea. The end of this lava stream is represented by a 2.5 m high ramp in 14 meters water depth running in approximately south-north direction. Under east wind a satellite photograph depicts a pattern of this ramp at a distance of $\sim$150 m against the direction of the wind.

A second example of this phenomenon can be seen in the Bay of Sozopol. There is a symmetric double ramp at a water depth of 20 m of a volcanic underwater wall 800 m long and 6 m high between Sozopol and the island of S. Peter [2]. In the satellite photograph taken under east wind, this double ramp, lying perpendicular to the wind direction shows patterns on both sides of the underwater wall.

Concluding, the theory of the bottom-to-surface-mapping (BTSM) process and the submarine geomorphology of the sea bottom are in a very good agreement.

References

[1] Beigelbeck, R., Paschke, F., Preisinger, A., and S. Aslanian - The image of the submarine geomorphological structures by water waves in satellite photographs. Geophysical Research Abstracts, Vol. 8, 06730, 2006.

[2] Preisinger, A., S. Aslanian, W.-D. Heinitz - Geomorphologic development of the Bay of Sozopol, Bulgaria (Black Sea) during the last 7500 years. Bulletin du Musée National de Varna, Vol. 51-52, p. 7-16, 2004.