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Coastal geomorphic processes and their relation to hydrodynamic conditions in Osmussaar Island, Baltic Sea

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Osmussaar is a 5 km long relict island of the Baltic Clint, overlain by Quaternary deposits, which emerged from the Baltic Sea 3000 years ago as a result of postglacial rebound. An Ordovician limestone cliff 7m high is the most characteristic feature on the northern part of the island, whereas 2–3m high gravel-pebble ridges cover the southern part of the island. The objective of the poster is to investigate the shoreline changes on Osmussaar Island and to study coastal formations and their evolution in relation to temporal variations in climatic and hydrodynamic conditions.

Topographic maps, aerial photographs and orthophotographs were compared to analyze the geomorphology, the changes in shoreline position and the nature of the shore processes. GPS-measurements were taken to assess short-term changes in shoreline positions. From 2004 until 2010, hand-held Garmin devices were used (accurate to within 3m), and after 2010, a Leica DGPS (accurate to within 1-2cm) was used. A leveling survey was carried out to evaluate changes in volumes of coastal features. The results were compared to the measurements carried out in 1970's. Several field tests have been carried out to determine the origin of accumulative material in the beach ridges, sediment flow directions and volumes of moving sediments. Among those field tests the study using painted sediments was carried out. Particles with the following diameters were used: 1-2.5cm (yellow), 2.5-5cm (red) and 5-10cm (blue). Painted limestone sediments were accumulated in 7kg piles and placed in 0.5-4m depths on limestone bench in September 2011. Their locations were recorded with DGPS. Study site was revisited in November and changes were registered.

The hydrodynamic study is based on measurements of waves and currents using the Recording Doppler Current Profiler. The wave data were used to calibrate a wave model using the SMB method, which was then applied to long-term (1966–2010) wave hindcasts.

Waves and sea level variations during storm surges (up to 2–3 m) are the main hydrodynamic factors responsible for coastal changes in Osmussaar. The main shore processes are erosion from the Osmussaar cliff, which recedes approximately 9 cm/yr, longshore southward transport of gravel-pebble and accumulation of material at the southern end of the island.

The most rapid changes have occurred during periods of increased cyclonic actvity, the last high phase of which occurred between the 1980s–1990s. The rate of coastal change increased from less than 0.3 m2/year to 2 m2/year per meter of shoreline compared to the period 1960-1980. Since the beginning of the 1980s, erosion occurred even in the former transport zone. The rate of shore changes has decreased during the last decade. However, the rate of changes still exceeds two times the volume of changes measured before the 1980s.

Investigations with painted sediments showed that the sediment piles were dispersed on the depths bigger than 2m, but remained nearly unchanged on the smaller depths. Such results might be caused by the low sea level and lack of strong storms during the study period.