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Seabed geomorphology of the Prokljan Lake – a Krka River estuary on the eastern Adriatic coast (Dalmatia)

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Vast areas of the shallow Adriatic shelf were exposed at the time of the Last Glacial Maximum lowstand. This enabled formation of lakes, river valleys and river floodplains that were submerged during the Holocene transgression. Here we present a study of the karst estuary of the Krka River located in central Dalmatia on the eastern Adriatic coast. The Krka River creates a 23 km long estuary extending north from the Šibenik Channel, over the Prokljan Lake, up to the tufa waterfall Skradinski buk. We used high resolution acoustic methods including sub-bottom profiler (SBP) coupled with multibeam echo sounder (MBES) (MBES bathymetry and MBES backscatter) and side-scan sonar (SSS) to investigate the submerged karst river valley and lake system that existed before the Holocene relative sea level rise. A total of 70 km of SBP profiles and a point cloud of 241 991 638 points in the area of 6.2 km^2 were collected during the surveys. Water depth ranges from 5 m b.s.l. in the most northern part of the study area, to 25 m b.s.l. in the southern part of the Prokljan lake.

To create a better geomorphological and geological classifications of the seabed, we made a network of 36 ground truthing stations where we sampled sediments with Van Veen grab sampler and obtained underwater images. Sediment samples were analyzed for grain size, bulk density, carbon and nitrogen concentrations, as well as mineralogical XRD analysis and magnetic susceptibility. We combined gathered data with GIS classification tools to create accurate seabed maps of the area. Our results also showed that well-defined submerged river canyon in the Prokljan Lake area was filled with three sedimentary units: fluvial, brackish and marine. Quaternary sediment thickness is up to 15 m. Seabed geomorphology of the investigated area is characterized by many submerged tufa barriers. They are similar to present barriers upstream of the Skradinski buk waterfall. These unique karst geomorphological features, that grow as algae and mosses are encrusted by carbonate, enabled formation of lakes, as well as prevented a marine flooding during the Holocene sea-level rise. The depth of each barrier (4.5 to 12 m b.s.l.), in connection to the onset of marine sedimentation within the estuary, can be used as an indicator of sea level. Barriers are emphasized on the MBES backscatter data as strong reflectors. Grain size of sampled sediments ranges from poorly sorted sand and gravel on underwater barriers to fine silt sediments in the deeper parts of Prokljan Lake. Larger sediment size on barriers is caused by tufa debris while fine silt is sedimented in the deeper parts of the basin. Grain size results vary for different geomorphological provinces, allowing for a more precise (GIS) classification and

description of the seabed.

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