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Holocene Sea-Level History Of Qatar: New Geomorphic And Sedimentary Evidence Using Differential GPS

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Abstract

Reconstructions of Holocene relative sea levels (RSL) from sedimentary or geomorphic records have important implications for projections of future RSL rise. Such records provide information on glacial isostatic adjustment (GIA), upper limits of ice shield ablation, and the preindustrial variability and possible anthropogenic impact on RSL rise in the future. They are useful to separate eustatic and steric effects from satellite and tide gauge data and provide a basis to tune rheological models of the Earth. RSL of a certain coastal site is a complex function of global (glacio-eustasy and steric effect), regional (e.g., GIA, hydro-isostasy, gravitational effects inducing deformation of the earth, upper/lower mantle viscosity, etc.) and local (sediment compaction, tectonic uplift/subsidence, and tide dynamics) parameters.

The coastline of Qatar is highly dynamic in this regard and experienced significant vertical and lateral shifts of its shorelines on comparatively short geological time scales. During the Last Glacial Maximum (LGM), the Arabian Gulf was dry. Flooding of the Arabian Gulf started some 14,000 years ago. The position of the present day coastline was reached and became flooded about 8,000 years ago. Existing literature data indicate that RSL rose a further 2 to 4 m until 6,000 years ago when it flooded significant parts of Qatar's present coastal areas before gradually decreasing to its present position about 2,000 years ago. However, not much detail is known on local variability, and precisely determined sea-level index points are scarce.

We compile new Holocene sea-level index points in form of beach ridge sequences (e.g., As-Sirriyah and Al-Shaqra areas), buried coral reefs and sabkha deposits (e.g., Doha, Corniche Road) and isolated beach ridges and subtidal deposits (e.g., Al-Shaqra and Khor Al-Adaid areas). Also buried intertidal to subtidal shells in living position, accessed by percussion coring and manual drilling at Al-Zareq area, were considered. Index points are precisely leveled by DGPS (vertical error: <2 cm) and radiocarbon (AMS) age dated.

Data from our coastal surveys reveal multiple evidence for a RSL highstand of up to about +2m QVD about 6,000 calibrated 14C years before present (yr BP), which lies at the lower end of previously estimated values. Indications for a RSL fall and substantial coastal regression since then have also been observed. RSL amplitudes of up to 5 or even 8 m since the mid-Holocene highstand, as proposed for the Arabian Gulf in earlier studies, are equivocal. They may be biased by heterogeneous index points, poor age constraints, or the inclusion of evidence from a larger region or different tectonic provinces, respectively. Late Pleistocene RSL seems to have been even more than 5 m higher than the mid-Holocene highstand based on DGPS measurements at Al-Shaqra and Khor Al-Adaid areas. It is envisaged to provide higher precision in the reconstruction of RSL and coastal changes in space and time, as well as information concerning possible differences between the east and west coasts of Qatar by applying a systematic dating and surveying approach along the entire coastline in the near future.