

The use of UAV data for environmental monitoring of the coastal area of Lake Sevan, Armenia under the increase in water level

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Introduction

High-mountainous Lake Sevan is located in Republic of Armenia, Southern Caucasus at an altitude of about 1900 m above sea level. The lake and its coastal area represent unique objects of highly detailed remote environmental monitoring due to the multidirectional dynamics of water level over the past 100 years. The artificial decrease in the lake water level began in 1930s, with the most intensive fall (over 10 m) from 1949 to 1962. In the 1990s, there was a slight increase in the level, then water level continued to fall until 2001.

According to the current program of Armenian government, the lake level is planned to rise by at least 6 m in the coming years. The current increase in water level of Lake Sevan leads to activation of both abrasive and accumulative coastal processes, intensification of eutrophication and mass flowering of lake waters. Planned increase in water level also threatens residential and recreational facilities which are abundant along shoreline of Lake Sevan. At the same time, the spatial and temporal differentiation between the current intensity of coastal processes and the state of coastal ecosystems is quite significant. Based on our results of multi-temporal analysis of old topographic maps and archive aerial and satellite high-resolution imagery we reconstructed large-scale dynamics of Lake Sevan shoreline for the period of over 100 years and determine for UAV surveys the areas with the most significant historical shoreline changes and more active contemporary coastal processes.

UAV surveys and derivative data

Repeated UAV optical and thermal surveys were conducted in summer of 2018 and 2019 for the all key areas. We use light-weighted multirotor UAVs DJI Phantom 4 Pro, equipped with 16 Mpix RGB-camera and thermal camera with 0,1 °C resolution. Altitudes of shooting we chosen as 100 and 200 m to cover more extended areas. Photogrammetric processing of UAV-data in Agisoft Metashape software were resulted to dense point clouds with average density from 300 to 500 points per sq. m; DSMs with with spatial and vertical resolution up to 10 cm, orthoimagery with 1–3 cm spatial resolution.

Monitoring of water eutrophication



Algae blooms in Lake Sevan have been periodically fixed since 1964 but with the current increase in lake level such mass blooms, as UAV fixed in July 2019 become the heaviest environmental issue for the whole lake areas bloom now

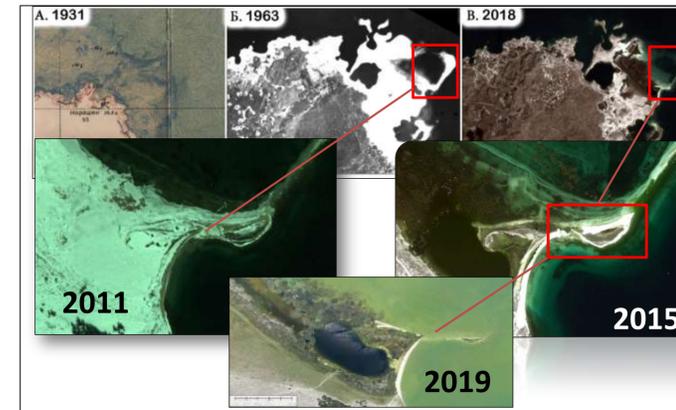
Detection of sources of water contamination by communal and livestock waste



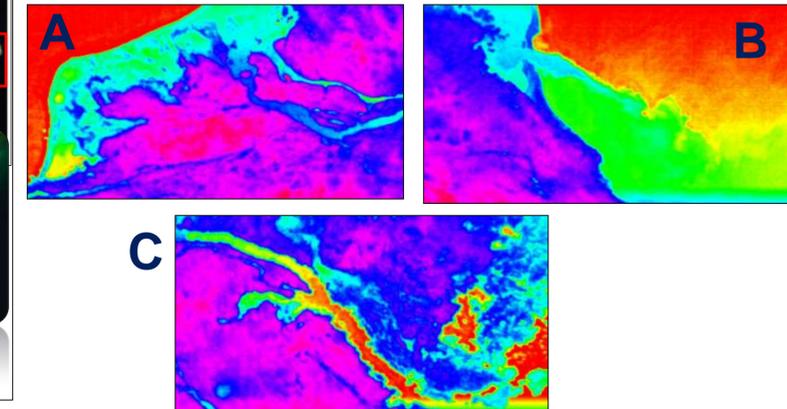
Uncontrolled release of sewage water from a recreational facility (red circle). Masrik

Small livestock farm in the coastal zone. Noratuz

Monitoring of coastal processes

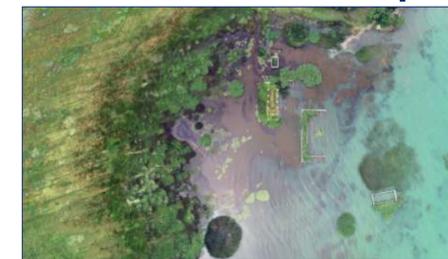


Complex of beach ridges, coastal lagoon and adjacent wetlands complex in Norashen, west shore of Sevan : history of creation and current degradation



Thermal UAV images, illustrated the submerge of wetlands in river delta (A); discharge of river debris (B); development of macrophytes in offshore zone . Masrik site

Detection of territories now at risk of inundation and spatial modeling under planned increase in water level

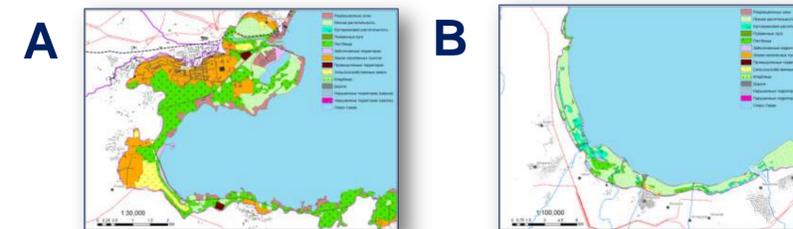


Submerged recreational facilities, 2018



Areas of potential inundation after planned rise in water level of Lake Sevan modeled from UAV-derived highly-detailed DSM

Large-scale land cover/land use mapping based on UAV data



A Razdan area, west Sevan : predominance of built-up areas and recreational facilities;

B – Martuni and Tsovinar, south shores of Sevan: small-sized croplands, pastures and degraded forests planted in 1960s

Conclusions

Thematic interpretation of acquired UAV data resulted to the integral synthetic assessment is made for the current environmental state of coastal ecosystems under risk. Among more vulnerable ecosystems are coastal lagoons with associated wetland complexes and planted coastal forests which being degraded and damaged as a result of increase in lake level and inadequate management can substantially contribute to the deterioration of integral water quality in Lake Sevan.

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