Caspian Sea Level Changes and Coastal Dynamics: A Case Study of the Gizil-Aghaj State Reserve Using Multi-Sensor Satellite Data

Bahruz Ahadov¹², Fakhraddin Kadirov¹², and Eric Jameson Fielding³
¹Ministry of Science and Education Republic of Azerbaijan, Institute of Geology and Geophysics, Baku, Azerbaijan (ahadovshao@gmail.com)
²Ministry of Science and Education Republic of Azerbaijan, Oil and Gas Institute, Baku, Azerbaijan
³NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

The decreasing sea level of the Caspian Sea is having a serious impact on coastal ecosystems and biodiversity. This study, conducted over a decade from 2014 to 2023, provides a comprehensive analysis of the coastal transformations in the Gizil-Aghaj State Reserve, Azerbaijan, using remote sensing technologies. By utilizing a combination of optical and radar satellite data, we mapped the evolving interplay between land and sea. Our research reveals a significant coastline shift, with the Caspian Sea receding to expose an additional 218 km² of land. This significant change was most apparent in the northeastern area, corresponding with regions experiencing substantial land subsidence. As the Caspian Sea's level decreases and the land sinks simultaneously, it's reasonable to expect that the shoreline would remain stable. In contrast to areas with land subsidence, places where the land is uplifting, along with the Caspian Sea's decreasing level, are likely to experience noticeable changes in their shoreline, suggesting a more dynamic and changing coastal area. These findings are crucial for understanding the fluctuations in the Caspian Sea level, likely influenced by a combination of natural geological processes, human activities, and broader climatic trends. The subsidence observed in some areas may be due to tectonic movements or human activities such as resource extraction. In contrast, the uplift seen in other areas, where there is evidence of building up over time, might be influenced by both anthropogenic factors and natural tectonic processes. Moreover, our study highlights the intricate relationship between coastal dynamics, vertical land movements, and environmental changes. It highlights the critical need for integrated and multi-dimensional monitoring approaches to address these complex interactions. These results not only contribute to a deeper understanding of the Gizil-Aghaj State Reserve's coastal ecosystem but also offer valuable perspectives on the Caspian Sea's response to climate change. Such insights are crucial for developing adaptive strategies for coastal management and conservation in an era marked by environmental uncertainties and changes.