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GEOMORPHOLOGICAL DYNAMICS OF COASTAL EROSION, A COMPREHENSIVE ANALYSIS OF TRANSFORMATIVE PROCESSES IN VULNERABLE ZONES

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Abstract
Remote sensing methods are widely used (1990s) to study erosion processes. Remote sensing makes an important contribution to the assessment of erosion at various spatial levels. The use of remote sensing techniques has the potential to identify eroded areas and monitor erosion processes at the regional level. lines, zones of influence of geomorphological processes and quantitative indicators. The coastline and its dynamics of the coastal areas of the Absheron peninsula (according to geomorphological zoning: from Sumgayitchay to the Jeyrankechmez river) were studied using ArcGIS software using Landsat MSS, TM, OLI images of the coastal zone of the Caspian Sea for 1986, 2002 and 2019. The calculation was carried out using the WLR statistics of the DSAS method. The calculation was carried out using the WLR statistics of the DSAS method. Negative values obtained during the calculation indicate erosion, while positive values indicate accretion. Remote sensing-based methods provide a cost-effective way to investigate erosion or build-up where there are no available areas or direct field methods are expensive. An analysis of the compatibility of remote sensing data for identifying areas of erosion and accretion processes (accumulation), monitoring, assessing the impact on soil and other objects, shows the use of a number of images to solve these problems.

Keywords: geomorphology, remote sensing, erosion and accretion processes

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Introduction

"Continental" and "marine" processes played an important role in the formation of the substrate of the coastal zone of the Absheron Peninsula. In conditions of low-contrast relief and the presence of a very poorly developed hydrographic network with a constant runoff, the nature and type of relief play the main role in the formation of the coastal zone. On the coasts of the Absheron (related to the areas of alpine folding), in areas of uplift, the main "peak" is given by abrasion and a smaller "peak" - coasts with dead cliffs and adjoining accumulative terraces. In areas of tectonic subsidence, accumulative leveled shores and abrasion-accumulative bay shores are most common; in stable areas - abrasion-accumulative bay, abrasion leveled and mainly coasts with dead cliffs and adjoining accumulative terraces. (L.G. Nikiforov, G.D. Solovieva, 1975).

In the absence of constantly functioning river systems in the formation of the coastal zone (all components of the physical and geographical environment), the main role belongs to the marine factor and, to some extent, the structure of the substrate. Under conditions of a stable sea level regime, the coastal land system expands into the aquatic system. In this process, an important role belongs to the arid-denudation process, the structure of the substrate and, very weakly, but still, the degree of loading of the rivers with sediments. Due to the increase in the relative load of the sediment flow, the front of the coastal zone advances towards the sea. This process was typical for the entire Pleistocene history of the coastal zone of the study region.

From the point of view of the complex of rocks, the forming Absheron Peninsula is distinguished by a variegated lithological structure. According to the research of Israfilbekov, I.A. Listengarten V.A. et al. (1980) identified the boundaries of lithological differences of 3 layers with different rock thick-nesses (with the exception of the overlying rocks first from the day surface). The thicknesses of the identified gradations of the first layer are <2, <5, 5-10, >10, >20 m. According to the totality of factors that determine the degree of homogeneity of the territory, the above authors have identified: regions - on a tectonic basis; regions - by geo-morphology and districts - by lithology. The region of the first order is composed of clayey rocks, the region of the second order is composed of sandy loams lying on clayey rocks, and the third region is composed of sands lying on clays of different geological tiers.

The climate of the peninsula is characterized as a climate of moderately warm semi-deserts and dry steppes. It is formed under the influence of com-plex circulation processes in the atmosphere. The processes of atmospheric circulation are influenced by solar radiation and the Main Caucasian Range, this is a natural obstacle for air masses invading from the north. Air masses invade the Absheron peninsula with significant speed winds, causing a strong "north" wind. Significantly affects the dynamics of atmospheric circulation and the Caspian Sea. It softens the intense heat in summer, and in winter it reduces the temperature of the cold air masses of the northern direction. Climatic factors largely determine the quantitative and qualitative characteristics of the process of groundwater formation. According to Israfilbekov I.A. and Listengarten V.A. (1980) in the region of study, on average, 227 mm of precipitation falls per year with an evaporation rate of 947 - 1344 mm. The total mineralization of atmospheric precipitation ranges from 56 to 208 mg/l, and its annual weighted average value is 102 mg/l. and 185 kg / ha / year of salts comes to the surface of the earth with solid precipitation. Of these, 13% is ac-counted for by NaCl. An important role in the formation of groundwater is played by the condensation of water vapour from the air. Hydrological factors determine the conditions for groundwater discharge, and these processes are most significantly influenced by long-term fluctuations in the level of the Caspian Sea. The drop in the level of the Caspian Sea leads to a certain de-crease in the level of groundwater in coastal areas and the associated decrease in water inflows.

The balance of ground and underground waters in the region is com-posed of infiltration of atmospheric precipitation and condensation moisture, recharge of lakes and formation waters of the productive stratum, infiltration of leaks from irrigation canals and wells, recharge of waste oil waters from water receivers and infiltration of leaks from water supply systems. According to the table, the incoming part of the groundwater supply balance is 174.5 million m3/year, and the discharge is 166.7 million m3/year. The share of underground runoff to the Caspian Sea is 98.0 million m3/year, and this is 59.0% of the total flow. So, for example, 1978-1995. There was a sharp rise in sea level by an average of 14 cm per year. The coast of the territory of Azerbaijan receded by about 10-20 m/year, and on the shallows within 50-100 m/year. And before that, i.e. prior to 1978 was preceded by a drop in sea level. The rise and fall of the sea level causes the activation of all geomorphological processes of the coast. According to the map of the horizontal dissection of the relief surface of the region, the dissection coefficient of significant indicators (2–4 km/km2) is typical for the western part of the Absheron Peninsula. This is due to the low-mountain relief and the corresponding substrate. According to the hydrogeological conditions in the region of study, two parts are clearly distinguished: the western and eastern Absheron (the settlement of Nardaran-Cape Gousany). Clay rocks of pre-Quaternary age are predominantly developed in Western Absheron. Groundwater is associated with individual areas of development of the Upper Pliocene and Quaternary sandy deposits, often has a sporadic distribution, increased and high mineralization. As a rule, these are brackish or salty waters. Only in rare cases are fresh and slightly brackish waters found. Eastern Absheron is characterized by almost ubiquitous distribution of groundwater; their occurrence varies from fractions of a meter to 20 m or more. The hypsometric position of the groundwater table is determined by absolute marks from 30 to minus 31 m. The direction of the groundwater flow is radial - from the central parts of the peninsula to the shores of the Caspian Sea. The mineralization and chemical composition of the waters is varied; there are waters from fresh hydro carbonate calcium to chloride sodium-magnesium brines (Fig 1).

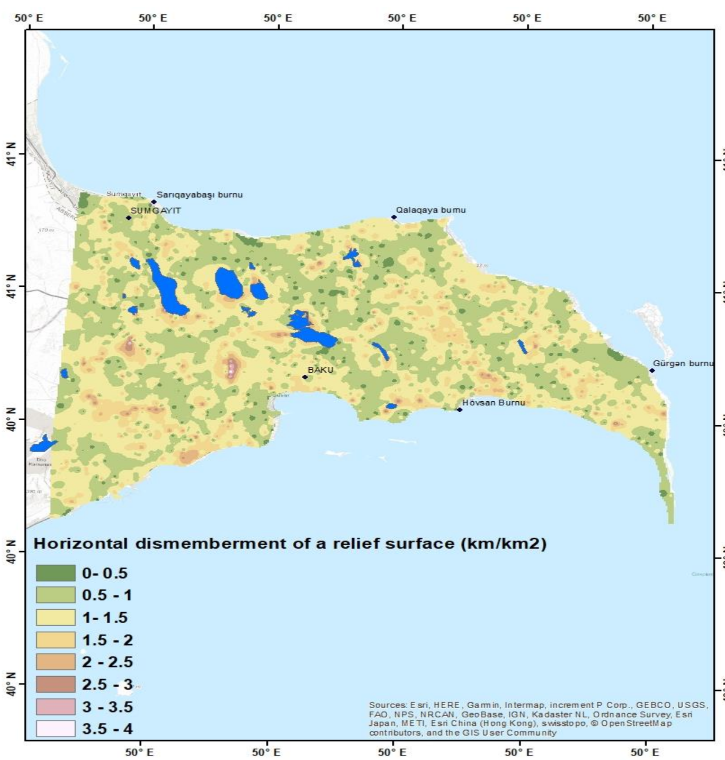

Fig 1. Map of the horizontal distribution of the relief surface

Sodium-magnesium chloride waters are found in areas where groundwater is recharged by waste oil waters. The rest of the territory has brackish or salty waters.

Geological and geomorphological factors are involved in the formation and circulation of groundwater. Ancient pre-Quaternary clayey rocks, exposed in the north western and western parts of the peninsula, are increasingly sub-merged to the east to a greater depth, where they are covered by a cover of Quaternary formations. The large thickness of the cover of Quaternary depos-its in the eastern part of Absheron favours the accumulation of groundwater.

The relief is also involved in the formation of groundwater. For the ac-cumulation of precipitation are hollows, ravines and other relief depressions.

The rivers of the study region are shallow and they directly carry their runoff (solid and liquid) towards the sea, sometimes without bringing their waters to the sea. These are: Sumgayitchay river - length 198 km, catchment basin 1751 km2. It starts from an absolute height of 2000 m. In the nutrition of the river, 90% falls on the share of rainwater. Jeyrankechmezchay the length of the river is 100 km, the catchment area is 896 km2. It originates from the south eastern slope of the Greater Caucasus, flows into the Caspian Sea. Has no tributaries. The flow of the river is formed mainly due to rainwater, there-fore it does not have a permanent flow.

The study of modern erosion processes is directly related to changes in the turbidity of river water, the nature and dynamics of sediments in lakes and on the seabed (coastal areas).

Materials and Methods

Remote sensing methods are widely used (1990s) to study erosion processes. Due to the presence on spacecraft of many sensors orbiting the Earth, remote sensing makes an important contribution to the assessment of erosion at various spatial levels. Studies have shown that the use of remote sensing methods has the potential to identify eroded areas and monitor erosion processes at the regional level. Several methodologies that are used to monitor erosion include spectral data, vegetation indices, and combinations of remote sensing data and morphological data.) Various semi-automated methods such as Tasseled Cap (Brightness, Greenness, Wetness) and DSAS (Digital Shoreline Analysis System) were used to determine shoreline and shoreline dynamics, geomorphological impact zone and quantitative indicators. The coastline and its dynamics of the coastal areas of the Absheron peninsula (according to geomorphological zoning: from Sumgaytchay to the Jeyrankechmez River) were studied using ArcGIS software using Landsat MSS, TM, OLI images of the coastal zone of the Caspian Sea for 1986, 2002 and 2019 .

The baseline was taken from a height of 200 m, and the processes of erosion and growth from this height to the coast were studied (Fig. 2). The calculation was carried out using the WLR statistics of the DSAS method.

WLR is a weighted linear regression, more robust data is given more emphasis or weight. The weight ("w") is defined as a function of the variance of the measurement uncertainty ("e") and is usually defined as: w = 1 / (e2)

The Accuracy field for the shoreline feature class in the DSAS data is used to calculate the weight, where: w = [1 /(precision2)] This is a typical weighting method, but it is important to note that there is no standard. an equation for determining a weighted linear regression (that is, other, more complex weighting schemes can be used). Our weighting method results in a best fit line that pays more attention to data points where coastline position accuracy is lower (years with lower +/- in accuracy field with more impact on best fit line) . When all coastlines are of the same accuracy, the emphasis will not be on any particular year, so the best fitting line should be the same as the line calculated for normal/standard linear regression. All other related statis-tics must also match (LRR = WLR, LR2 = WR2, LSE = WSE and LCI = WCI). However, one exception is that the equation used to calculate the WSE has a weight component that is reversed (when all coastline weights are equivalent) when the weight is one. This results in different reported standard errors between weighted and normal linear regression. In these cases, there is no need for weighted regression (because all accuracies are the same), so weighted linear regression values should be ignored (Fig 2).

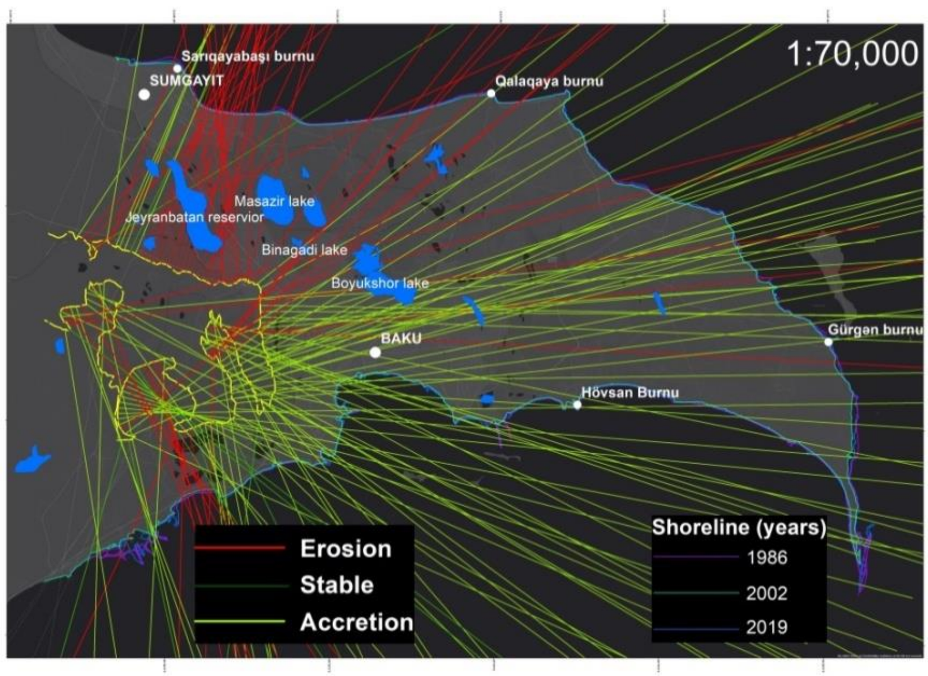

Figure 2. Erosion direction

Results and discussions

Negative values obtained during the calculation indicate erosion, and positive values indicate accretion (Fig. 3).

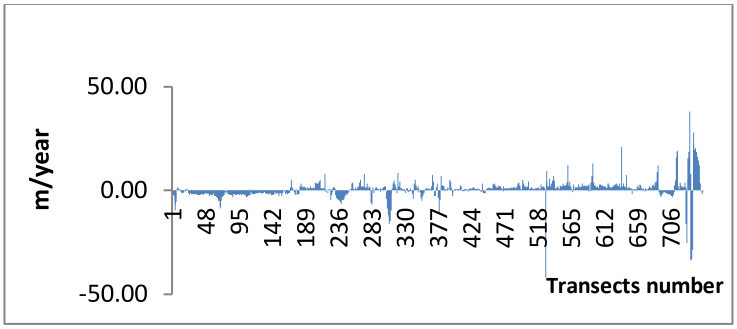

Figure 3. Erosion and accretion evaluation

Remote sensing data is an important source of information for mapping, monitoring and predicting growth and erosion. With the help of remote sensing of the Earth, one can quickly obtain information on the development of erosion processes, observe them both at a particular moment and over time. Although satellite imagery is expensive, research materials are sometimes provided free of charge. Thus, the main advantages of remote sensing are speed, accuracy and price. Remote sensing-based methods provide a cost-effective way to investigate erosion or build up where there are no accessible areas or direct field methods are expensive (Fig 4).

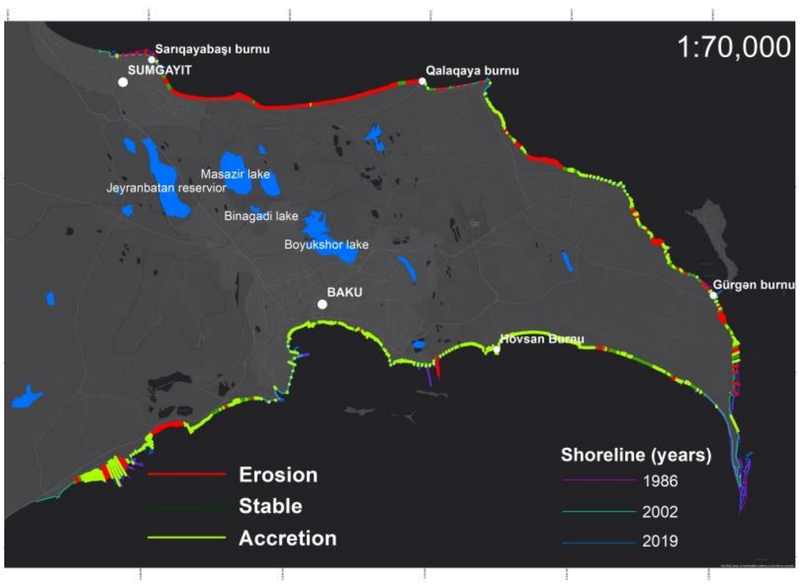

Figure 4. Coastal zone assessment

Conclusion

An analysis of the compatibility of remote sensing data for identifying areas of erosion and accretion processes (accumulation), monitoring, assessing the impact on soil and other objects, shows the use of a number of images to solve these problems. Satellite images make it possible to quickly and timely fix the presence and intensity of erosion processes, predict their impact on the relief, soils, arable land and landscape systems, as well as approve a number of measures to minimize environmental impact.

Acknowledgements

We would like to emphasize the cost-effectiveness of remote sensing-based methods in investigating erosion processes and coastal dynamics. These methods offer valuable insights, especially in areas where direct field measurements are expensive or inaccessible. The compatibility analysis of remote sensing data for identifying erosion and accretion areas, monitoring processes, and assessing their impacts on soil and other objects has highlighted the im-portance of utilizing multiple images to solve these complex problems.

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