TƏBİƏT ELMLƏRİ

NATURAL SCIENCES

DOI: https://doi.org/10.36719/2789-6919/47/64-67

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Climate, Radiation Balance, Atmospheric Periodicity, and Hydrothermal Regime of the Absheron Peninsula

Abstract

The Absheron Peninsula, located on the western coast of the Caspian Sea, is characterized by a semi-arid climate and frequent wind activity. These factors and proximity to the sea, combine to create a distinctive agroclimatic setting. This study examines the region's solar radiation patterns, atmospheric periodicity and hydrothermal balance using a combination of observational data and climate assessments. The results reveal a persistent imbalance between solar energy supply and scarce water availability, along with significant meteorological influences that limit agricultural productivity. In response, this paper outlines tailored land use and sustainable farming strategies adapted to the ecological context of the Absheron Peninsula.

Keywords: *Absheron Peninsula, semi-arid climate, solar radiation, wind regime, hydrothermal balance, drought stress, adaptive agriculture*

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Abşeron yarımadasının iqlimi, radiasiya balansı, atmosfer dövriliyi və hidrotermal rejimi

Xülasə

Xəzər dənizinin qərb sahilində yerləşən Abşeron yarımadası quraq iqlimi və tez-tez əsən küləkləri ilə seçilir. Bu amillər və dənizlə əhatə olunması birlikdə bölgədə özünəxas aqroiqlim mühiti formalaşdırır. Bu tədqiqatda müşahidə məlumatları əsasında Abşeron yarımadasının günəş radiasiya rejimi, atmosfer dövrləri və hidrotermal balansı qiymətləndirilir. Nəticələr göstərir ki, bol günəş enerjisi qəbulu ilə qıt su ehtiyatları arasındakı tarazsızlıq kənd təsərrüfatının məhsuldarlığını əhəmiyyətli dərəcədə məhdudlaşdırır. Bu səbəbdən, məqalədə Abşeron yarımadasının iqlim şəraitinə uyğun kənd təsərrüfatı strategiyaları təqdim olunur.

Açar sözlər: *Abşeron yarımadası, yarımsəhra iqlimi, günəş radiasiyası, külək rejimi, hidrotermal balans, quraqlıq stresi, aqroiqlimə uyğunlaşma*

Introduction

The Absheron Peninsula is located at the intersection of several climate zones, resulting in a landscape shaped by arid influences, maritime moisture, and continental air masses. This confluence generates an unpredictable and dynamic climate that places pressure on traditional farming systems. Rainfall can be sparse and erratic, while high summer temperatures and strong seasonal winds add further stress to both crops and soils. The peninsula has a peculiarity of spring frosts that affect blooming plants.

Baku and its surrounding areas experience intensified climatic effects due to ongoing urban development. Industrial activity and dense infrastructure contribute to the urban heat island effect, altering local temperature and humidity regimes (Kalnay et al., 1996). These changes have made localized adaptation strategies essential for agricultural sustainability.

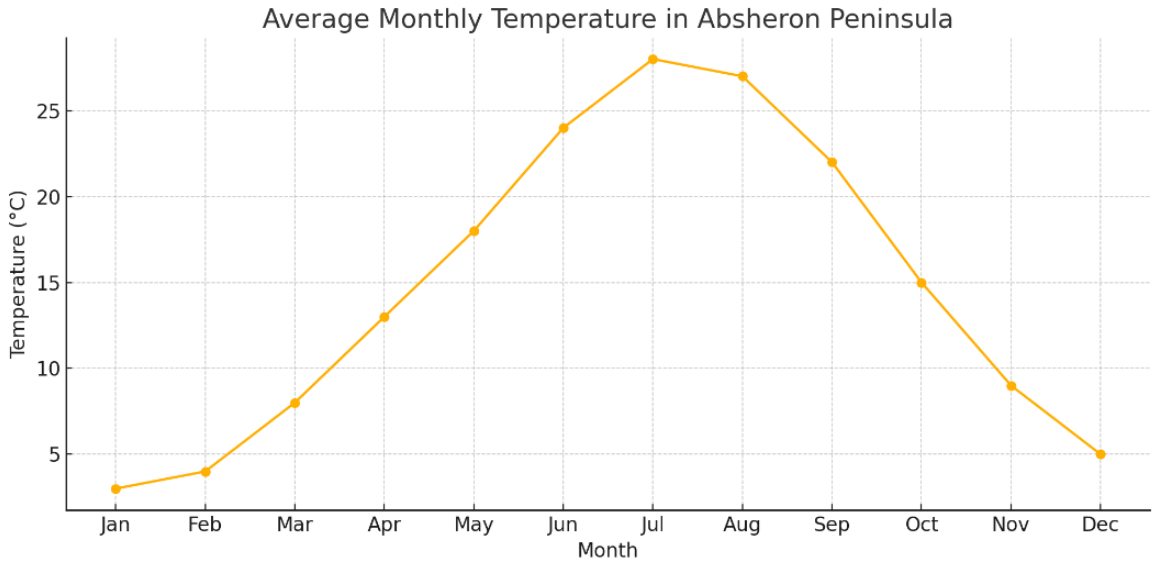
This paper synthesizes current climate data to analyze solar radiation inputs, seasonal atmospheric circulation, and the hydrothermal regime. The objective is to support precision agriculture, reduce erosion risk, and inform climate-adaptive strategies for land and water management in Absheron peninsula.

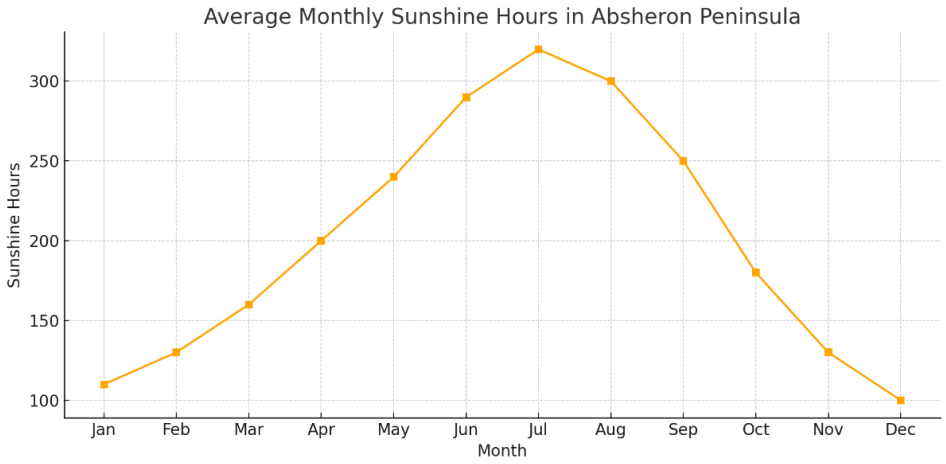
Research

Geographical and Climatic Context. Climatic conditions on the peninsula have become increasingly unstable in recent decades. Rainfall distribution has grown more irregular, with periods of drought and unseasonal storms occurring more frequently. According to climate assessments, such shifts are consistent with broader patterns linked to global warming and changing atmospheric circulation (IPCC, 2022; Riebsame, et al., 1995; Peel, Finlayson, McMahon, 2007).

The Caspian Sea plays a moderating role during winter but also contributes to increased humidity and evaporation in summer. These effects lead to heightened water loss from soils, particularly during mid-summer heatwaves that often surpass 35°C.

Solar Radiation and Precipitation. Daily radiation in the peninsula peaks in summer exceed 25 MJ/m², particularly in June and July. The semi-arid climate, combined with high evaporation rates and uneven rainfall distribution, makes proper water management essential for local agriculture. Annual rainfall is limited (usually 200–300 mm), and rising temperatures in the summer months quickly deplete soil moisture. Crops commonly grown in Absheron, such as almonds, olives, figs, pomegranates and grapes, are relatively drought-tolerant but still require supplemental irrigation during critical growth stages, especially blooming and fruit set. Some studies suggest that in such climates, the total annual irrigation requirement may range from 3,500 to 5,500 cubic meters per hectare, depending on soil and crop type.





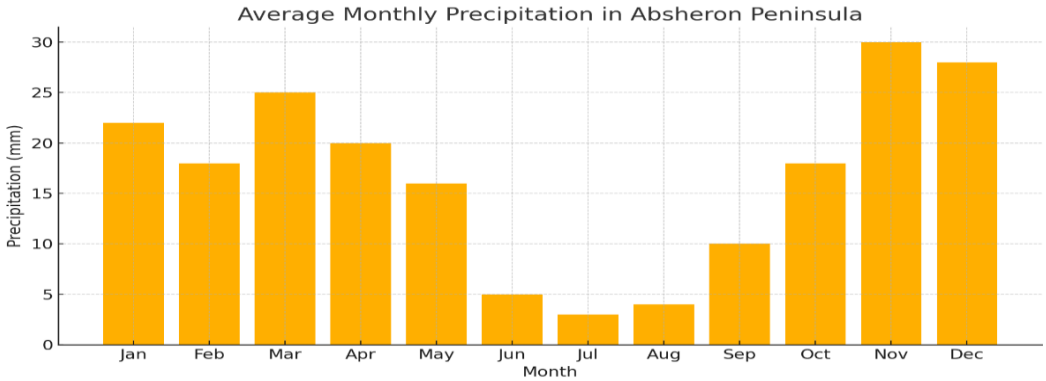
Seasonal Atmospheric Patterns. Absheron peninsulas weather is strongly influenced by shifting pressure systems and Caspian-origin air masses. This results in clearly defined but sometimes unpredictable seasons. Winter on the peninsula is mildy cold and damp, rainy, often windy, with cloudy skies and rare snowfalls. Spring with moderate precipitation, with frequent, sometimes gusty winds and late frosts. Summer is hot, but with a breeze, sometimes the wind gets stronger, evenings are damp and stuffy. Autumn becomes cooler, rainy and windy.

The region's prevailing winds are the cold Khazri from north and warm Gilavar from south have substantial effects on microclimates. These winds affect not only ambient temperatures but also moisture loss and salinity patterns in topsoil layers (Zonn, 2011). The winds also cause soil erosion and the denudation of fields. The east and southeast winds bring sand and pollute the atmosphere.

Hydrothermal Regime and Agricultural Impact. The hydrothermal coefficient (HTC) of the Absheron Peninsula in the spring- autumn period fluctuates between 0.03 and 0.7, which confirms its arid nature. For example, in July, the average temperature is 27°C, and the precipitation level is 3.3 mm, and if calculated using the formula HTC = 10 × P / ∑ T, the HTC will be about 0.04. A coefficient below 0.5 means severe drought. This indicates that the weather conditions in the summer are extremely dry. The growing season lasts up to 180 days, but more than 120 days a year are at risk of drought. As a result, effective irrigation and soil moisture retention are critical (Wilhite, Glantz, 1985; UNESCO, 2021).

Crops like almond, fig, olive, and certain grape varieties show promise if supported by modern water-saving methods, including mulching and precise irrigation timing. However, salt accumulation due to shallow groundwater tables and limited drainage remains a constraint. Practices such as raised beds, soil flushing, and cultivation of salt-tolerant cultivars offer partial solutions (Shiklomanov, 2000; Allen, Pereira, Raes, Smith, 1998; Dinku, et al., 2014).

Geospatial mapping and agroclimatic zoning are needed to identify microzones within Absheron where a particular plant grows best. These findings will be integrated into planning tools that help optimize irrigation schedules and land use strategies (Peel et al., 2007; Giorgi, 2006).



Conclusion

The climate of the Absheron Peninsula, although challenging, offers opportunities for agricultural innovation. Both environmental sustainability and productivity can be improved through targeted interventions.

Key Recommendations:

- Promote solar-powered agriculture, including greenhouse heating and drip irrigation
- Introduce salt- and drought-tolerant cultivars suitable for arid soil conditions
- Implement windbreaks and vegetative buffers to reduce soil erosion
- Apply agro-climatic zoning to guide site-specific agricultural decisions
- Introduction of late blooming cultivars to avoid spring frosts.

Future of the Absheron Peninsula agricultural success will depend on integrating climate intelligence into policy, planning, and practice.

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Received: 06.04.2025
Approved: 11.07.2025