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**Research Article****Shamakhi safari park eco-tourism potential: Biodiversity, sustainability, and climate monitoring****Ulviyya Mammadova***Department of Soil Ecology, AR Ministry of Science and Education, Institute of Soil Science and Agrochemistry Azerbaijan, Baku, AZ1073, Mammad Rahim 5.**Department of Plant Protection, AR Ministry of Agriculture, Research Institute of Fruit and Tea Growing Azerbaijan, Guba, AZ4035, Quba-Xaçmaz chaussée, Zardabi settlement.***ABSTRACT**

The investigation employs advanced remote sensing techniques to precisely delineate the geo-geographical characteristics of Shamakhi Safari Park, covering approximately 480 hectares within a larger 620-hectare forested landscape bounded. Located at 40°45'32.16"N and 48°32'26.52"E, high-resolution satellite imagery from Esri World Imagery and Maxar, with a spatial resolution of 0.46 meters and positional accuracy of 5 meters, facilitated detailed mapping of the park's terrain, vegetation cover, and habitat diversity. The analysis identified heterogeneous topography comprising mountainous relief, dense oak and pine forests, steppe areas, and wetland ecosystems, which collectively contribute to the park's rich biodiversity, including habitats for several protected and endemic species. Extending roughly 3.43 km in length, the park's adjacency to Pırgulu State Preserve and historic villages enhances its ecological connectivity and cultural value, reinforcing its role as a significant eco-tourism hub. The study's results provide a scientific foundation for sustainable tourism development and natural resource management by highlighting critical conservation areas, promoting habitat restoration, and encouraging local community involvement to ensure long-term ecological resilience. Finally, the aim of this study is to inform evidence-based strategies that balance ecological preservation with sustainable tourism growth, supporting both environmental integrity and socio-economic benefits for the region.

Keywords: Shamakhi safari park; eco-tourism; biodiversity; sustainability; climate.**Correspondence**

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Article History

Received: June 05, 2025

Accepted: August 02, 2025

Published: August 31, 2025

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INTRODUCTION

The present research centers on Shamakhi Safari Park, located in the Shamakhi district of the Republic along the Pırgulu–Lahij route (Aerospace Map, 2025; Mammadova, 2022) near the İsmayilli district. Distinguished by its abundant biodiversity, preserved natural zones, and unique ecosystems, the park presents a largely underexplored study area within the Caucasus region, adding novelty and relevance to environmental and cultural research in Azerbaijan. Given the park's enclosed nature, the study applied remote sensing methods and GIS analyses based on data from multiple aerospace sources. Geo-geographical parameters were derived from Open Street Map (Aerospace Map, 2025; Climate condition of Safari Park, 2025), Bing Map, and Google Earth imagery, supported by Esri World Imagery. The integration of modern technology not only allowed for accurate mapping and monitoring of the area but also aligned the research with contemporary environmental and archaeological practices. The topography of Shamakhi Safari Park reflects the broader landscape of the Shamakhi region, situated in the western part of Azerbaijan at the foothills of the Caucasus Mountains. This terrain is predominantly mountainous and forested, with elevations varying across the park. Forested areas, dominated by oak and pine, form an essential ecological

component, maintaining biodiversity and supporting ecosystem stability. Steppe zones, characterized by open grasslands and shrubs, provide critical habitats and feeding grounds for herbivorous species. The relief also features ponds and wetland areas, fostering aquatic habitats that contribute to species richness, particularly for birdlife and other aquatic organisms. Elevated viewpoints across the park offer panoramic perspectives, enhancing both ecological appreciation and cultural value by connecting visitors to the natural heritage of the Caucasus landscape. This linkage between environmental features and the region's cultural identity underlines the park's interdisciplinary importance, bridging ecology, geography, and heritage studies.

By uniting mountainous terrain, forested landscapes, steppe habitats, and aquatic ecosystems, Shamakhi Safari Park emerges as a natural complex where biological diversity coexists with historical and cultural significance. The combination of an underexplored geographic focus, the application of advanced geospatial technologies, and the recognition of cultural heritage ensures that this study contributes meaningfully to both scientific understanding and heritage conservation in Azerbaijan (Aerospace Map, 2025; Climate condition of Safari Park, 2023; Mammadova, 2022; San Diego Zoo Global, 2023; Mammadova., 2022). The park is surrounded by the Pırgulu State Preserve, Demırchi mud volcano, Demırchi village, Avakhil village, Talishnuru village, Erchimán village, Nagarakhana village, and Yusif Mammadaliyev settlement, which is home to the Astrophysical Observatory. The map reveals the park's abundant forest cover and intriguing natural features, along with diverse relief possibilities. Shamakhi Safari Park experiences a generally mild climate during the hot months of the year and harsh conditions in the cold season. Azerbaijan's territory is under the influence of a continental climate, which varies across regions. The Shamakhi district, owing to its mountainous geography, exhibits diverse climatic conditions.

Below is an overview of the climate at Shamakhi Safari Park:

During the summer months, the weather is typically hot and dry. In July and August, the average temperature ranges from 25-30°C (Mammadova, 2022). Visitors can enjoy the natural beauty of warm weather and cool nights during this period. In winter, the weather is mild, turning colder in higher mountainous regions. December, January, and February see average temperatures between 0°C and 5°C (Mammadova, 2022). Snowfall is a common occurrence in the region during winter due to its mountainous terrain. Spring and autumn bring milder weather with frequent rainfall, creating a favorable environment for vegetation.

Consideration of economic and environmental sustainability, in alignment with local infrastructure and financial factors, is essential. The climate of Shamakhi Safari Park plays a pivotal role in shaping diverse ecosystems, including forests, mountains, wetlands, and steppe areas. This diversity supports various plant and animal species, allowing visitors to explore the park and experience different climatic conditions throughout the year. Research conducted in the Pırgulu territory, as referenced by Mammadova (2012), covers the current area of the Safari Park. This underscores the need for further investigation and the development of eco-tourism initiatives in line with international standards. This paper aims to assess the region's natural possibilities (Mammadova, 2022; Mammadova, 2023) potential and formulate strategies for sustainable tourism. The scope of this paper is to examine the biodiversity richness of Shamakhi Safari Park, analyze the potential for eco-tourism through sustainable climate strategies, and evaluate how community participation influences natural resource management.

MATERIALS AND METHODS

The research was carried out in Shamakhi Safari Park, located along the Lahij–Pırgulu main road in the Pırgulu region. To examine the area, remote sensing methods were applied with a particular focus on radar-based techniques, supported by additional aerospace data. High-resolution satellite imagery (Esri World Imagery, Maxar) with 0.46 m spatial resolution and 5 m positional accuracy was used to map and analyze the park's features. The study area covers 480 hectares within a larger 620-hectare forest zone, forming a perimeter of approximately 63.9 km. The precise geographical position of the park was defined between 40°45'32.16"N and 48°32'26s 52"E. These datasets provided a reliable basis for identifying the park's boundaries, spatial parameters, and ecological context, ensuring consistency in subsequent analysis (Aerospace Map, 2025; Mammadova, 2022). The geospatial analysis was performed using ArcGIS Pro 3.2 and QGIS 3.34 software, integrating datasets from Sentinel-2 MSI, Sentinel-1 SAR, Google Earth Pro, Bing Maps, and Open Street Map. High-resolution orthorectified imagery from Maxar was processed for feature extraction, while RADAR data from Sentinel-1 was used to assess surface structure and elevation changes. A multi-stage workflow was applied: 1) initial visual inspection of high-resolution images; 2) semi-automated classification using supervised machine learning algorithms in ArcGIS Pro; 3) structural pattern recognition through lineament and shape analysis. Validation and authentication of the identified sites involved cross-referencing imagery from multiple temporal

datasets, ground-truth verification through GPS field surveys conducted in accessible areas, and comparison with existing topographic maps. The spatial scale of the analysis ranged from 1:1,000 to 1: 5,000 for detailed mapping, with positional error margins estimated between ± 2 m for GPS-confirmed features and ± 5 m for satellite-only detections. By including these methodological details—covering platforms, software, analytical criteria, and validation procedures—the research ensures transparency, reproducibility, and scientific rigor in the identification and analysis of potential geoglyph-like structures within Shamakhi Safari Park.

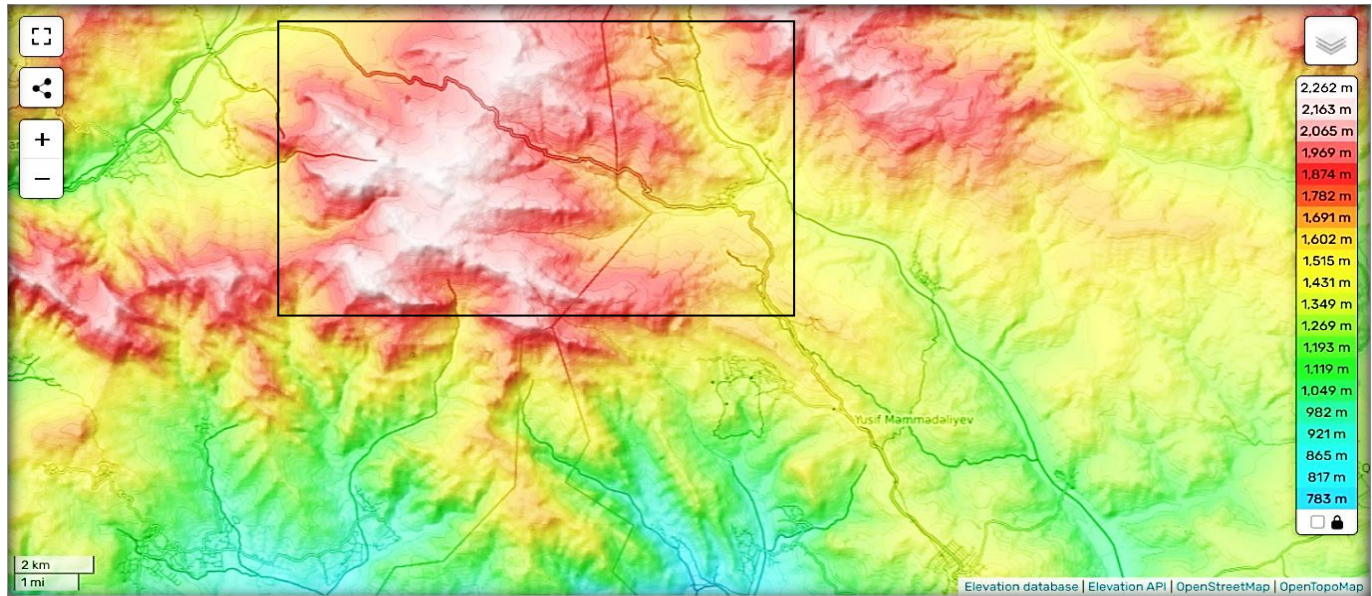


Figure 1. General view of Shamakhi safari park on Open Street Map (Aerospace Map, 2025).

Remote investigation methods play a pivotal role in evaluating the eco-tourism potential of lakes (Mammadova, 2023), enabling researchers and environmentalists to acquire valuable data without directly impacting sensitive ecosystems. Several remote investigation methods tailored for assessing lake eco-tourism potential have been used in the study. The utilization of satellite imagery offers a holistic perspective of the entire lake and its environs. Remote sensing technologies aid in evaluating vegetation health, water quality, and changes in land use, providing critical insights into the overall ecological health of the lake. GIS enables the integration and analysis of diverse spatial data, encompassing topography, land cover, and hydrology. Through the creation of layered maps, researchers can pinpoint potential eco-tourism (Mammadova, 2022; Mammadova, 2023) sites, evaluate accessibility, and plan sustainable development in the lake's vicinity.



Figure 2. Winter in Safari Park (Shamakhi Saffari Park, 2025).

Employing remote sensing technologies, such as sonar and echo sounding for bathymetric surveys, assists in mapping the lake's underwater topography. This data is indispensable for comprehending depth variations, submerged features, and potential underwater attractions for eco-tourism activities.

Table 1. The climate monitoring within five years in the research area.

Latitude: 40.601441		Longitude: 48.574677		Elevation: 504.86		StdPres: 95.44		Time Zone: -999		Time Period: 2017 - 2024				Note: Gridded Data	
Annual Heating and Humidification Design Conditions															
Coldest Month	Heating DB (°C)		Humidification DP/MCDB and HR (°C)						Coldest month WS/MCDB (°C)				MCWS/PCWD to 99.6% DB (°C)		
	99.6%	99%	99.6%			99%			0.4%		1%		MCWS	PCWD	
			DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB			
1	37.1	35.8	17.0	1.8	-3.1	16.2	2.0	-2.0	9.3	2.0	8.2	5.4	2.9	175.2	
Annual Cooling, Dehumidification, and Enthalpy Design Conditions															
Hottest Month	Hottest Month DB Range	Cooling DB/MCWB (°C)						Evaporation WB/MCDB (°C)						MCWS/PCWD to 0.4% DB (°C)	
		0.4%		1%		2%		0.4%		1%		2%		MCWS	PCWD
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB		
7	13.0	-6.0	22.8	-4.7	22.1	34.4	21.5	24.2	35.2	23.2	33.9	22.4	32.8	4.5	134
Dehumidification DP/MCDB and HR (°C)															
Ext. Max B (°C)	0.4%						1%						2%		
	0.4%		1%		2%		0.4%		1%		2%		Ext. Max B (°C)		
	DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth		MCDB	Enth
-10.0	12.7	23.3	-8.5	12.1	23.0	15.4	11.5	22.8	61.9	33.7	59.5	32.2	57.5	30.9	27.1
Extreme Annual Design Conditions															
Extreme Annual WS (°C)			Extreme Annual Temperature (°C)				n-Year Return Period Values of Extreme Temperature (°C)								
			Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years		
1%	2.5%	5%	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
8.0	7.0	6.2	DB	-7.9	39.3	1.9	1.2	-9.3	40.2	-10.4	41.0	-11.5	41.7	-12.9	42.6
			WB	-9.5	25.8	2.1	0.7	-10.9	26.4	-12.1	26.8	-13.3	27.2	-14.8	27.7
Monthly Climatic Design Conditions															
		Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Temperatures, (°C) Degree Days/Degree-Hours	DBAvg	14.48	2.6	3.6	8.0	12.6	19.2	24.3	26.9	26.4	21.5	15.3	8.5	4.0	
	DBStd	9.44	3.1	3.9	4.0	4.4	3.4	3.2	2.7	3.1	3.4	3.9	4.1	3.4	
	HDD10.0	787	228	180	88	22	0	0	0	0	0	7	73	185	
	HDD18.3	2281	485	413	320	178	28	1	0	0	10	106	293	442	
	CDD10.0	2422	0	1	26	99	286	427	524	509	345	171	28	1	
	CDD18.3	884	0	0	0	6	57	180	266	253	107	12	0	0	
	CDH23.3	9638	0	0	9	100	645	2008	3049	2777	936	109	1	0	
	CDH26.7	4817	0	0	0	24	197	1004	1678	1525	368	18	0	0	

Wind (m/s)														
WSAvg	2.9	2.8	3.0	2.9	2.7	2.6	3.0	3.4	3.4	3.0	2.7	2.7	2.7	
Precipitation (mm)														
PrecAv.	0	386	542	632	655	658	475	262	231	593	766	674	411	
PreMax	0	1027	1154	1406	1967	1366	0	1211	1066	0	0	1865	1167	
PreMin	0	75	79	157	97	85	15	2	1	19	159	55	17	
PreStd	0	253	333	378	397	382	457	294	258	549	582	432	295	
Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures (°C)														
0.4%	DB	14.7	17.6	24.5	29.5	33.5	37.2	39.1	39.1	34.6	29.2	21.6	15.6	
		MCWB	7.0	9.1	13.7	17.0	20.3	21.4	23.7	23.2	21.3	19.0	13.1	8.9
	2%	DB	11.4	14.7	20.9	26.2	30.9	35.6	37.2	37.1	32.5	26.2	18.7	12.9
		MCWB	5.4	7.5	11.5	15.7	19.1	21.2	23.2	22.9	20.9	18.1	12.3	7.3
	5%	DB	9.0	12.3	18.1	23.4	28.8	34.0	35.8	35.7	30.7	24.0	16.5	10.6
		MCWB	4.0	6.1	10.5	14.4	18.2	20.6	22.8	21.8	20.4	16.8	11.2	6.4
	10%	DB	7.1	9.6	15.4	20.8	27.0	32.3	34.3	34.2	28.8	21.9	14.2	8.5
		MCWB	3.2	4.9	8.8	13.3	17.4	20.2	21.9	21.5	19.6	15.6	10.0	5.6
Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperatures (°C)														
0.4%	WB	7.7	9.7	14.2	18.3	21.7	23.4	25.6	25.4	23.2	19.8	15.1	10.0	
		MCDB	12.5	16.2	23.0	28.2	32.1	34.7	37.2	36.7	32.8	27.1	19.9	14.2
	2%	WB	6.0	8.2	12.4	16.4	20.0	22.4	24.5	24.1	21.9	18.5	13.0	8.3
		MCDB	10.3	14.4	19.6	25.2	29.1	33.3	35.7	35.0	30.6	25.4	16.9	11.7
	5%	WB	4.8	6.6	10.8	15.0	19.0	21.5	23.5	23.1	20.9	17.3	11.8	7.0
		MCDB	8.1	11.8	17.7	22.4	27.6	32.6	34.1	33.8	29.6	23.6	15.3	9.7
	10%	WB	3.7	5.2	9.2	13.6	17.9	20.7	22.6	22.2	19.9	16.1	10.6	5.9
		MCDB	6.3	9.2	14.8	20.4	25.8	31.4	33.1	32.8	27.8	20.8	13.5	8.1
Mean Daily Temperature Range (°C)														
5% DB	MDBR	8.0	9.4	11.6	12.3	13.0	13.4	13.0	13.0	11.8	10.0	8.5	7.6	
	MCDBR	11.6	12.5	13.4	13.3	13.5	13.7	13.3	13.4	12.2	10.8	9.8	10.2	
	MCWB	6.7	6.9	7.2	7.1	6.6	6.6	6.3	6.6	5.9	5.3	5.2	5.9	
	5% WB	MCDBR	10.5	12.1	13.1	13.1	13.3	13.6	13.1	13.2	12.1	10.5	9.1	9.0
		MCWB	6.4	6.9	7.2	7.1	6.6	6.6	6.3	6.5	5.9	5.3	5.0	5.4
		MDWB	10.5	12.1	13.1	13.1	13.3	13.6	13.1	13.2	12.1	10.5	9.1	9.0
Clear Sky Solar Irradiance (W m ⁻²)														
Ebn,noon	735	745.8	742	732.6	761.9	782.2	735.7	738.9	731.1	702.9	705.2	719.0		
Edn,noon	122	161.8	205	237.6	224.9	207.9	230.5	214.8	192.2	165.1	127.7	108.3		
All-Sky Solar Radiation (W m ⁻²)														
RadAvg	70	94.11	140	182.2	242.32	278.65	263.91	236.81	179.29	121.13	82.63	62.8		
RadStd	28	39.63	55.3	68.75	68.03	61.34	56.92	56.52	55.16	47.44	33.59	24.06		

All seasons contribute to the effectiveness and vibrancy of the vegetation process in the park's ecosystem. The mountainous region, particularly in the Pargulu area of Shamakhi district, experiences the direct impact of wind (Mammadova, 2023; Mammadova, 2022), especially in areas without woodlands. The extensive open spaces in

Shamakhi Safari Park make it highly advantageous for solar energy potential. Solar energy, a clean and sustainable source, can be harnessed effectively in areas with ample sunlight exposure. The region's rich sunshine hours throughout the day, coupled with large open spaces, present a high potential for solar energy (Mammadova, 2021; Mammadova, 2022) production through the installation of solar panels. This energy source could be used to meet the park's energy needs, aligning with its mission to protect the natural environment and reduce environmental impact. Utilizing solar energy (Mammadova, 2021; Mammadova, 2022) can also enhance the park's energy independence, especially in remote or difficult-to-access areas. Additionally, solar energy projects can serve as educational tools, raising awareness among visitors about sustainable energy use and contributing to the park's mission of environmental conservation. Aerial surveys conducted using drones capture high-resolution images and videos, offering detailed information on the lake's shoreline, vegetation cover, and surrounding landscape. Drones prove particularly useful for accessing challenging terrains and monitoring changes over time. Deployment of remote water quality sensors enables continuous monitoring of key parameters such as temperature, pH, dissolved oxygen, and nutrient levels. Real-time data contributes to assessing the ecological health of the lake and determining its suitability for various eco-tourism activities. Although not traditional remote sensing methods, monitoring social media platforms and online discussions provides valuable insights into public perceptions, preferences, and concerns regarding the lake. This information informs eco-tourism planning and community engagement strategies. Remote weather stations and climate monitoring tools collect data on temperature, precipitation, and seasonal variations. This information is crucial for predicting visitor trends, planning seasonal eco-tourism events (Mammadova, 2022; Mammadova, 2023), and assessing the impact of climate change on the lake ecosystem. On the long-term monitoring Mammadova, 2022; Mammadova, 2022), the essential climate parameters were defined and given below. Although their departure marks the end of the immediate spectacle, their presence leaves an enduring impression on the memory of this serene lake—a poignant reminder of the interconnectedness between the natural world and the beauty that unfolds when humans and wildlife coexist harmoniously. Generally, ecotourism is based on the climate condition, which demands long-term monitoring (Mammadova, 2022; Mammadova, 2022) in the territory as well. temperature showings in the territory have been defined according to aerospace monitoring for a year. The picked low and high-wind data allow realizing the planning of the tourism tours and facilities of sports kinds for developing the eco-tourism sector in four seasons around the studied lake. It is clear from the graph below (Climate condition of Safari Park, 2025).

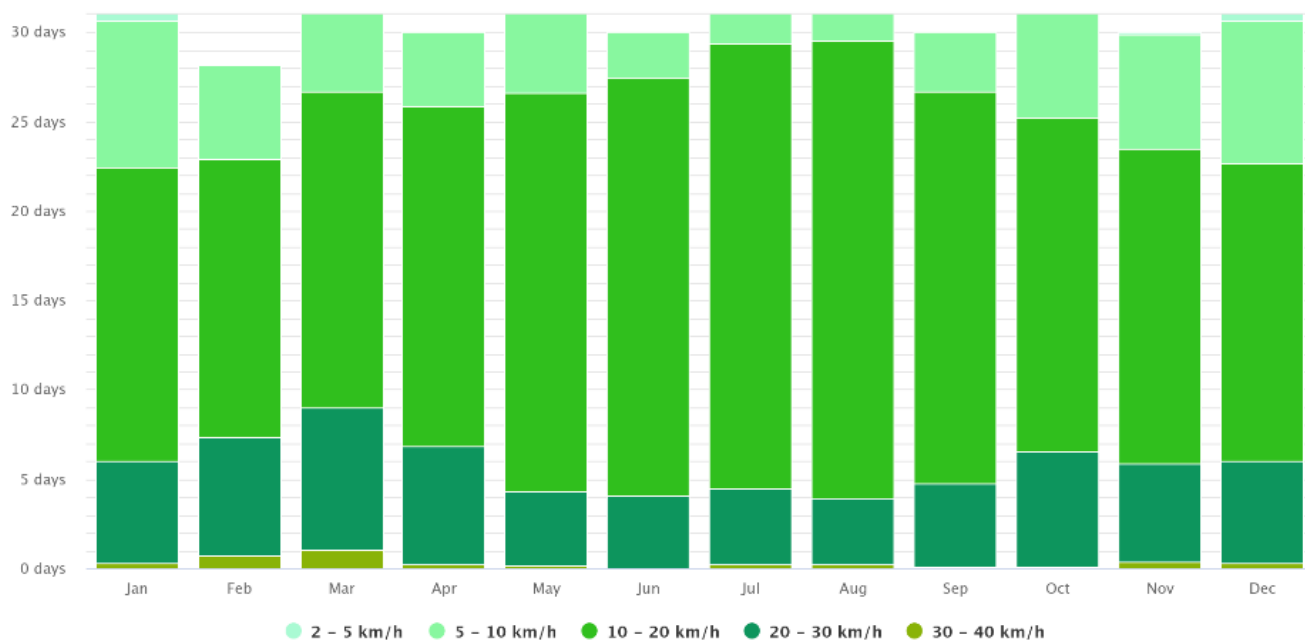


Figure 3. Annual average in wind speed (Climate condition of Safari Park, 2025).

From figure (3) it is clear that the along the year 10-20 km/h wind speed is more, from January to December, featuring an average daily high wind speed, that happens on the mountainous territories. July and August are considered more windy and sunny months in Shamakhi Saffary Park. The wind speed between 30-40 km/h is less here, especially. Conversely, the cold season persists for 3.8 months, lasting from November 19 to March 14, with an average daily

high temperature falling below 9°C. January holds the title for the coldest month in Shamakhi, registering an average low of -5°C and a high of 3°C. Shamakhi Safari Park offers an ecosystem that reflects the rich natural diversity of Azerbaijan. In this paper, the biodiversity and ecosystem features of the park will be discussed, and the importance of various living species and ecosystems in the region will be examined. Shamakhi Safari Park is hosting various species of flora (Mammadova, 2023; Mammadova, 2022) and fauna. During the captivating autumn season, Yashil Gol in Shamakhi emerges as a sanctuary for migratory birds embarking on their remarkable journey. As the temperatures gradually drop and the landscape, adorned with the vibrant hues of fall foliage, this scenic destination becomes a vital pitstop for a diverse array of avian travelers. With the approaching autumn and the days growing shorter, Yashil Gol becomes witness to a mesmerizing spectacle—the graceful descent of migratory birds onto its tranquil waters. The surrounding trees, now painted in shades of red, orange, and gold, form a breathtaking backdrop to the unfolding drama at the water's edge. The arrival of migratory birds during their autumn flight underscores the significance of Yashil Gol as a pivotal waypoint in their migration route. The serene lake offers a haven for these winged nomads, providing a much-needed opportunity to rest, refuel, and recharge before continuing their challenging journey to warmer climates. The diversity of migratory bird species landing on Yashil Gol enhances the enchantment of this natural phenomenon. From elegant cranes and swift swallows to majestic waterfowl, a myriad of species graces the skies, finding solace in the tranquil environs of the lake. The air resonates with melodic calls and the rhythmic beating of wings as these birds create a harmonious symphony against the backdrop of the autumnal landscape. Enthusiastic observers and bird aficionados converge to witness this annual spectacle, equipped with binoculars and cameras to capture the fleeting moments of avian elegance. The gathering of migratory birds on Yashil Gol not only underscores the resilience and determination of these creatures but also emphasizes the critical importance of preserving such natural habitats for their survival. As the sun sets over Yashil Gol, casting warm hues across the sky, the migratory birds take flight once more, resuming their journey southward. Steppe areas, especially dominated by shrubs and grasses, provide an ecosystem that supports different species. Mountainous regions provide a special ecosystem with high-altitude endemic species. Ponds and wetlands increase biodiversity by supporting waterfowl and other aquatic ecosystems. Shamakhi Safari Park conducts various conservation and rehabilitation projects to preserve biodiversity and sustainably manage ecosystems. It adopts policies and practices that promote the sustainable use of natural resources.



Figure 4. The tour to the wild life of Shamakhi safari park in pictures in September (Shamakhi safari park, 2025; wild farm for alpacas, 2025).

It focuses on raising environmental awareness by organizing educational programs for visitors. Ultimately, Shamakhi Safari Park supports sustainable conservation efforts as an area rich in biodiversity and ecosystem diversity and offers visitors the opportunity to experience the natural environment.

Alpaca (*Vicugna pacos*), lama (*Lama glama*), Bizon (*Bison*), wild yak (*Bos mutus*), Peacock (*Pavo*), are given in Figure 4. where the photos were taken from Shamakhi Safari Park's photo gallery. Various birds such as hawks, eagles, ospreys, vultures, and ducks color the sky of the park. Aquatic animals such as crane fish and barbel fish live in the ponds of the park. Arthropods such as butterflies and bees complete the biodiversity. The forested areas of the park are home to many species of trees, birds, and mammals, creating a complex ecosystem. Safari The richness of the flora (Mammadova, 2023; Mammadova, 2022) and fauna of the park has been determined through field studies and biodiversity inventories. Protection of these habitats is of critical importance in maintaining the ecological balance of the region. Shamakhi Safari Park is home to a unique biodiversity in the Shamakhi district of Azerbaijan. The park attracts attention with its various ecosystems and habitats. In this paper, the important ecosystems and habitats of Shamakhi Safari Park will be examined and its contribution to the region's biodiversity will be discussed. These studies have provided important information to identify endemic species in the region and identify areas that need to be protected. The park includes various ecosystems, wetlands, forests, and steppes. As for the climate condition of the studied area, the Atmospheric precipitation (Mammadova, 2022) directly influences the natural condition of the Safari Park depending on the season.

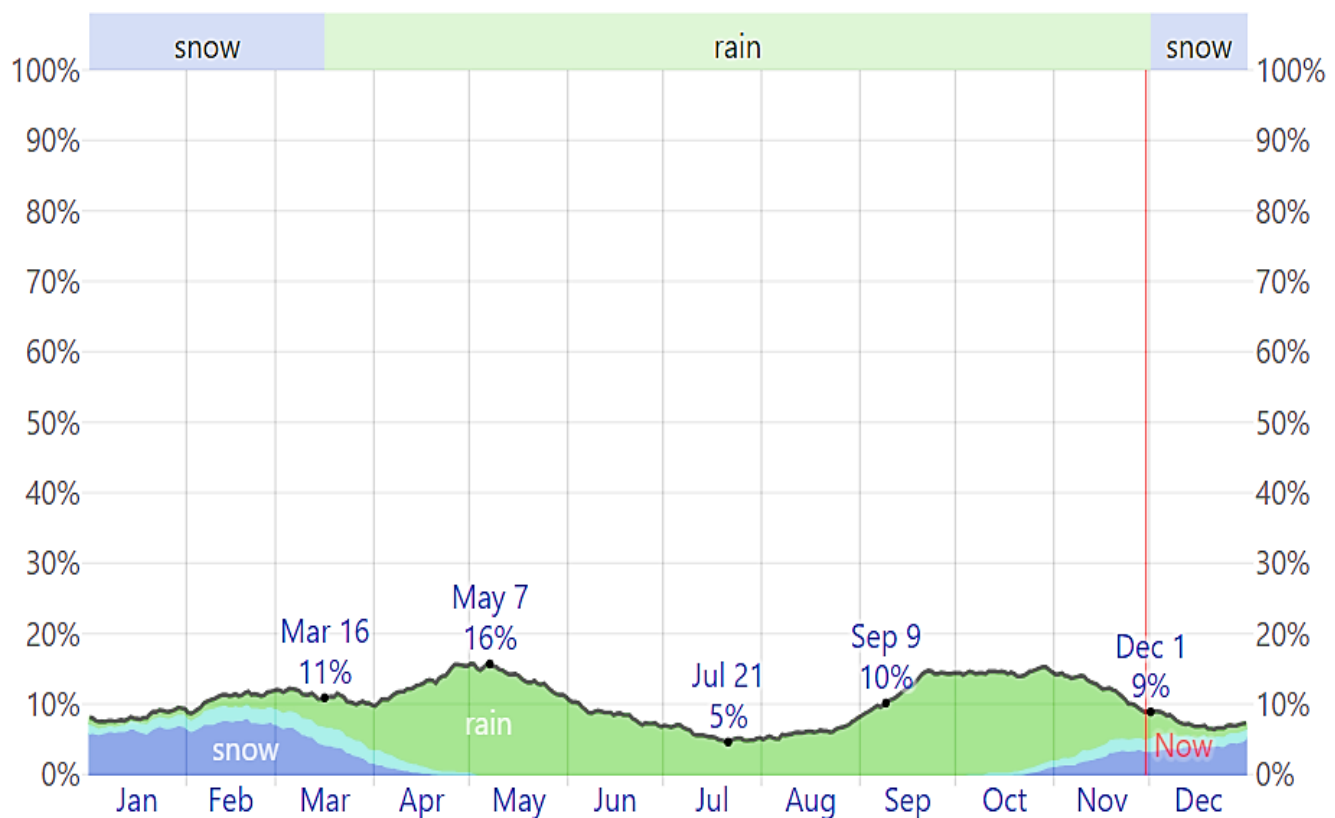


Figure 5. Daily precipitation chance within 2017- 2022 (Climate condition of safari park, 2025).

It is seen from Figure 5 that a wet day is defined as one with at least 1.00 millimeters of liquid or liquid-equivalent precipitation. The probability of encountering wet days in Shamakhi Safari Park fluctuates throughout the year. The wetter season spans 8.9 months, from September 9 to June 4, with a likelihood greater than 10% of any given day being a wet day. October holds the record for the highest number of wet days in Shamakhi, averaging 4.5 days with at least 1.00 millimeters of precipitation. Conversely, the drier season lasts 3.1 months, occurring from June 4 to September 9. July marks the month with the fewest wet days in Shamakhi, averaging 1.7 days with at least 1.00 millimeters of precipitation. Within the category of wet days, distinctions are made based on whether they experience rain alone, snow alone, or a mixture of both. This categorization reflects the changing patterns of precipitation in Shamakhi over the year. Rain alone predominates for 8.5 months, from March 16 to December 1, with October having

the highest frequency of rain alone, averaging 4.3 days. Snow alone dominates for 3.5 months, spanning from December 1 to March 16. February sees the most days with snow alone in Shamakhi, averaging 2.1 days. Shamakhi Safari Park is famous for its large forest areas.



Figure 6. The Tour to the wild life of Shamakhi safari park in pictures in September (Shamakhi safari park, 2025; wild farm for alpacas, 2025).

This biodiversity is because the park has different habitats. Forest areas, steppes, highlands, and wetlands support the park's rich biodiversity. The park hosts local tree species such as forest and pine. In addition, heather, wildflowers, and other shrubs enrich the vegetation of the park. Water lilies and other aquatic plants that spread in the ponds revive the water ecosystem. In addition to herbivorous mammals such as deer, gazelle, roe deer, mountain goat, mouflon, bison, alpaca, and llama, there are also reptiles such as snakes, lizards, and turtles in natural conditions. Although their departure marks the end of the immediate spectacle, their presence leaves an enduring impression on the memory of this serene lake—a poignant reminder of the interconnectedness between the natural world and the beauty that unfolds when humans and wildlife coexist harmoniously (Yulianto et al., 2023). These forests are home to many different species of plants and animals that support the park's biodiversity. Local tree species, birds, and other forest inhabitants contribute to the park's ecological balance. Steppe fields are one of the various ecosystems of the park. These areas mainly include open land dominated by grasses and shrubs. The steppe habitat allows the adaptation and diversification of different species found in the region. The park's wetlands are home to waterfowl and other aquatic ecosystems. Ponds play an important role in managing water resources and protecting wetland habitats in the region. The park's wetlands are an attractive destination, especially for bird watchers. Shamakhi Safari Park has a diverse topography with mountainous areas. The mountainous areas provide different climates and vegetation that enrich the park's biodiversity. Mountainous habitats are important, especially for endemic species living in high-altitude areas. Open land and pastures are spread over large areas within the park. These areas serve as grazing grounds for large herbivorous mammals. Mouflon, antelope, and other herbivorous species exhibit their natural behavior in these open areas. Shamakhi Safari Park carries out various ecological projects to protect and sustainably manage each ecosystem. Tree-planting initiatives aimed at increasing biodiversity, along with ecosystem protection and habitat restoration projects, play a vital role in ensuring the sustainable use of natural resources within Shamakhi Safari Park. These efforts help preserve the ecological integrity of the park's diverse habitats. To deepen the understanding of the geoglyph-like formations observed in the park, it is essential to place them within a comparative global framework by examining similar structures found in Peru, Saudi Arabia, and Kazakhstan. This comparison involves analyzing the geometric shapes, sizes, and design patterns of these formations to identify both shared and distinctive morphological

characteristics. Additionally, evaluating their potential functions—whether as ceremonial or ritual sites, territorial markers, or alignments with astronomical events—provides insight into their cultural significance. Finally, considering the environmental conditions, cultural backgrounds, and historical contexts in which these geoglyphs exist allows for a comprehensive understanding of how geography and human activity influenced their creation and preservation. By integrating these morphological, functional, and contextual perspectives, the study can better situate the Shamakhi formations within the broader landscape of global geoglyph research, offering clearer hypotheses about their origins and significance. In conclusion, Shamakhi Safari Park is a destination that stands out for its natural richness, focusing on the conservation and promotion of biodiversity with its various ecosystems and habitats. The park's ecosystem conservation efforts aim.

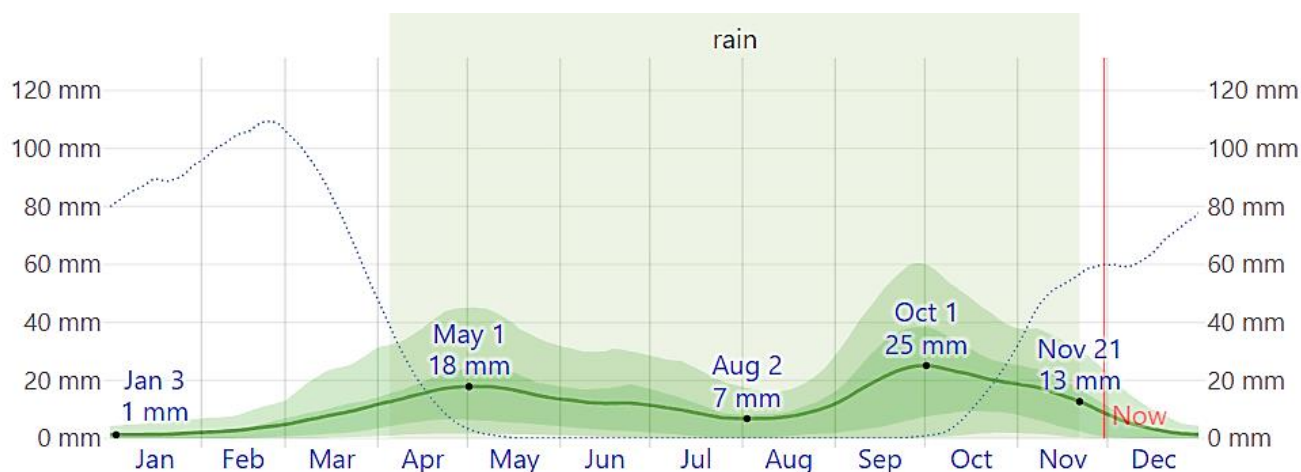


Figure 7. Average monthly rainfall within 2017- 2022 (Climate condition of Safari park, 2025).

From figure (7) it is clear that accumulated precipitation is represented over a 31-day cycle centered around each day of the year, not just the monthly total, to illustrate the variability throughout the months. In Shamakhi Safari Park, seasonal changes in monthly precipitation can be observed. The rainy season in the region lasts for 7.5 months, from April 5th to November 21st, with a minimum of 13 millimeters of precipitation recorded in a 31-day cycle. The month with the highest rainfall in Safari Park is October, with an average of 22 millimeters of precipitation. The dry season lasts for 4.5 months, from November 21st to April 5th. In Shamakhi Safari Park, the month with the least rainfall is January, with an average of 1 millimeter of precipitation. Shamakhi Safari Park is an eco-tourism destination established in the Shamakhi district of Azerbaijan to protect natural resources and biodiversity. In this paper, the eco-tourism and sustainability efforts of Shamakhi Safari Park will be examined, and the strategies adopted by the park in areas such as protecting natural resources, social participation, contributing to the local economy, and creating environmental awareness will be discussed. Shamakhi Safari Park aims to protect natural resources within the concept of eco-tourism. In this framework, ecosystem protection projects and rehabilitation works are being carried out. Afforestation and vegetation restoration projects aimed at increasing biodiversity are being implemented. Water resource management and sustainable water use strategies are adopted. The park focuses on the following strategies to create social participation and environmental awareness. Local community education and awareness-raising programs are organized. To ensure community participation, local people are allowed to be involved in the management of the park. Environmental education guiding services and informative materials are offered to visitors. Shamakhi Safari Park focuses on the following strategies to strike a balance between sustainable tourism and local economic development. Cooperation and joint projects with local entrepreneurs are supported. Marketing strategies that support the sale of local products and local handicrafts are implemented. Job opportunities and educational opportunities are provided to the local people. Coming to Environmental Impact Management and Sustainable Transportation Strategies, the park focuses on the aforementioned strategies to minimize environmental impact and promote sustainable transportation. Waste management and recycling programs are implemented. Public transport or environmentally friendly transport options are recommended for visitors. The use of energy-saving and environmentally friendly technologies is encouraged. Shamakhi Safari Park offers visitors unique experiences by organizing nature-friendly and educational eco-tourism activities. These activities include nature walks, bird-watching tours, photo safaris,

and eco-camping opportunities. According to climate parameters all actions can be organized and planned perfectly by local plenipotentiaries and the companies with tourist tours.

It is known from Figure 8 that the comfort level of humidity based on the dew point was assessed, which determines whether perspiration will evaporate from the skin, thereby influencing the body's cooling. Lower dew points create a drier feeling, while higher dew points result in a more humid sensation. Unlike temperature, which often varies significantly between night and day, the dew point tends to change more gradually. Therefore, while the temperature

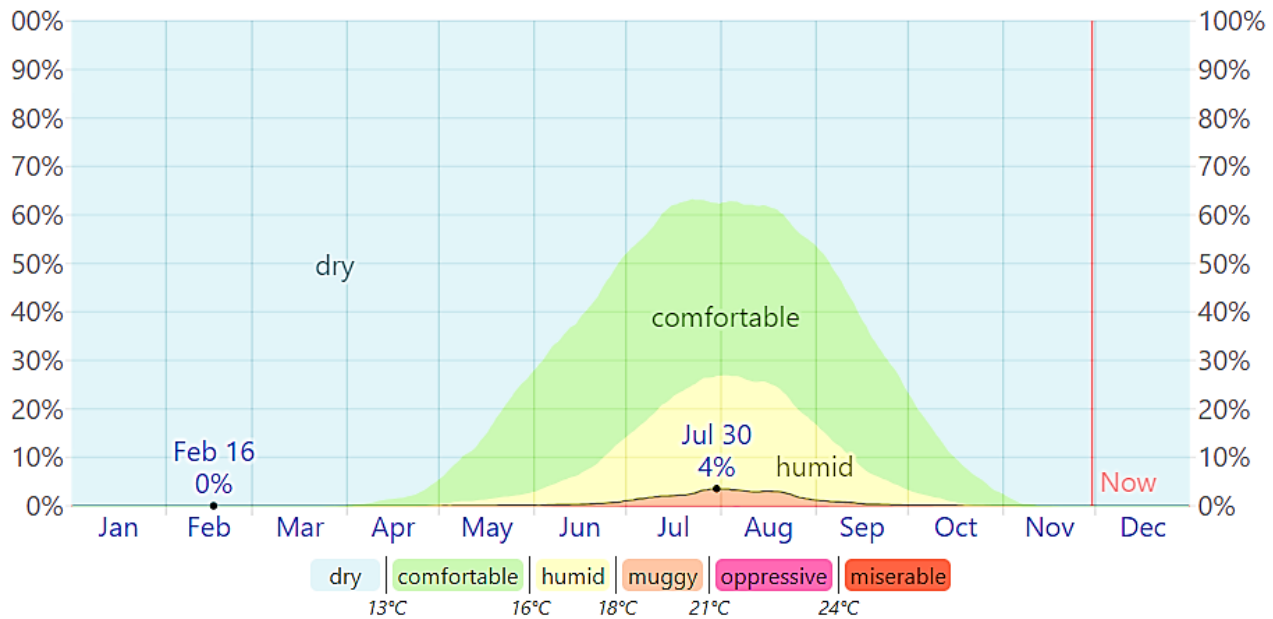


Figure 8. Humidity comfort levels within 2017- 2022 (Climate condition of Safari park, 2025).

may decrease at night, a muggy day is typically followed by a muggy night. The perceived humidity level in Shamakhi, quantified by the percentage of time in which the humidity comfort level is categorized as muggy, oppressive, or miserable, shows minimal variation throughout the year, remaining consistently within a 2% range. One of the necessary facts is local wind directions (Climate condition of Safari Park, 2025; Mammadova, 2022; Mammadova, 2023; San Diego Zoo Global, 2023) which has been determined and given below in the next figure.

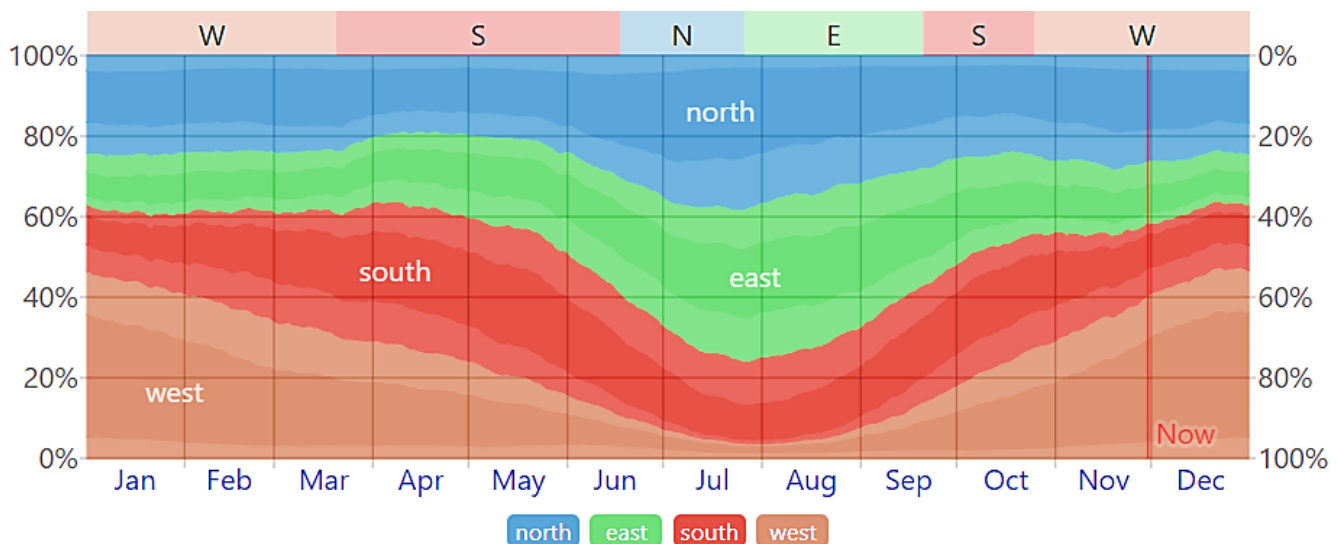


Figure 9. Wind directions within 2017- 2022 (Climate condition of Safari park, 2025).

As seen in figure (9) the prevailing average hourly wind direction in Shamakhi Safari Park exhibits seasonal variations. The wind predominantly comes from the south for 2.9 months, spanning from March 20 to June 17, and for 1.2 months, from September 20 to October 25, reaching its highest percentage of 37% on May 13. From July 26 to September 20,

the wind is most frequently from the east for 1.8 months (Mammadova U.F.13, 2022; San Diego Zoo Global, 2023), with a peak percentage of 39% on August 7. Subsequently, the wind primarily originates from the west for 4.8 months, from October 25 to March 20, reaching its peak percentage of 47% on January 1 (Climate condition of Safari Park, 2025; Mammadova, 2023; Mammadova, 2022).

Shamakhi Safari Park pursues the mission of protecting natural resources, contributing to the local economy, and raising social awareness by adopting the principles of eco-tourism and sustainability. These efforts enable the park to fulfill its environmental and social responsibility beyond being just a tourist destination Shamakhi Safari Park provides visitors with an experience in harmony with nature by offering opportunities such as nature walks, bird-watching tours, and ecotourism activities. The Safari Park, located in the Shamakhi district of Azerbaijan, is an eco-tourism destination that stands out for its natural wealth and biodiversity. This paper will examine the eco-tourism opportunities offered by Shamakhi Safari Park and discuss various activities aimed at providing visitors with an experience in harmony with nature. Shamakhi Safari Park offers its guests nature walks and trekking tours organized in the park. These activities allow visitors to explore the park's unique ecosystem. These walks accompanied by professional guides allow you to see the richness of flora and fauna of the region more closely. The park's wetlands and forested areas provide an ideal environment for bird watchers. Organized bird-watching tours provide a chance to observe and recognize different species of birds. These tours offer the opportunity to observe the natural behavior of birds in various habitats of the park. Safari tours organized for photography lovers offer an opportunity to see the park's unique landscapes and wildlife up close. Winter tourism is so popular here because of a lot of snowfall in the mountains. The annual snowfall fact proves it.

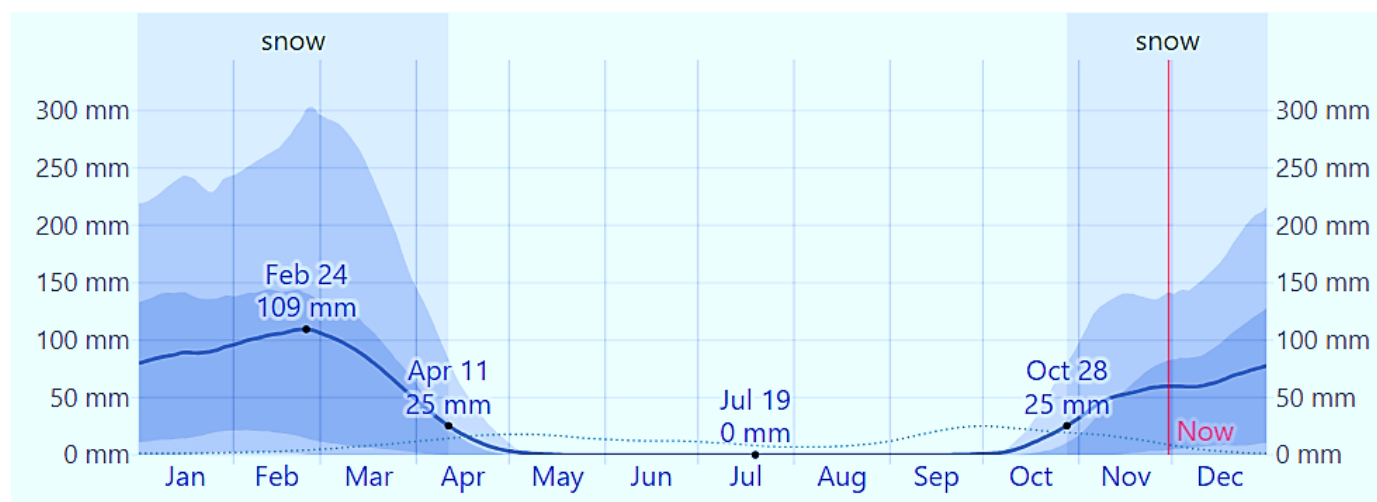


Figure.10. Average monthly snowfall 2017- 2022 (Climate condition of Safari park, 2025).

As mentioned in figure (10) similar to rainfall, the snowfall accumulated over a rolling 31-day period was assessed and centered around each day of the year. Shamakhi Safari Park exhibits significant seasonal variations in monthly snowfall. The snowy season lasts for 5.5 months, spanning from October 28 to April 11, with a cumulative 31-day snowfall of at least 25 millimeters. February stands out as the month with the highest snowfall in Shamakhi, averaging 105 millimeters. Conversely, the snow-free season lasts for 6.5 months, from April 11 to October 28. The period around July 19 experiences the least snowfall, with an average total accumulation of 0 millimeters. These tours, accompanied by professional photographers, give visitors a chance to make unforgettable memories. Shamakhi Safari Park provides eco-campers to provide visitors with a stay experience immersed in nature. These campsites offer the opportunity to set up tents, giving visitors the chance to camp while being aware of protecting the natural environment. The park organizes various educational programs within the scope of eco-tourism. These programs provide visitors with information on the conservation of natural resources, biodiversity, and sustainable tourism. It also hosts activities aimed at developing sensitivity to local ecosystems and natural habitats. The park organizes organic produce markets to contribute to the local economy and promote sustainable agriculture. These markets give visitors the chance to discover and support local products. As a result, Shamakhi Safari Park aims to increase awareness of not only natural beauty but also environmental awareness and sustainable tourism with its eco-tourism opportunities. Aerospace materials and remote sensing method gives us an opportunity to define the tourism score (Climate condition of Safari Park, 2025) for the territory.



Figure 11. Tourism score due to climate condition in Shamakhi safari park within 2017- 2022.

As mentioned in figure (11), to assess the overall pleasantness of the weather in Shamakhi Safari Park over the year, two travel scores were calculated. The tourism score prioritizes clear, rainless days with perceived temperatures ranging between 18°C and 27°C. According to this metric, the optimal time for general outdoor tourist activities in Shamakhi Safari Park is from early June to mid-September, with the highest score typically occurring in the last week of August. It continues its mission to protect local ecosystems and promote sustainability while offering visitors an unforgettable nature experience. Sustainable tourism strategies should aim at effective protection of natural resources in the region and minimal impact of tourism on the ecosystem. Shamakhi Safari Park is a destination that aims to promote sustainable tourism while protecting natural resources and biodiversity. In this paper, the sustainable tourism strategies of Shamakhi Safari Park will be examined and the strategies adopted in areas such as natural resource protection, social participation, contribution to the local economy, and environmental education will be discussed. Shamakhi Safari Park adopts various strategies for the sustainable management of natural resources. The participation of local people in eco-tourism management and decision-making processes is critical to the success of sustainable tourism. Shamakhi Safari Park is an important nature reserve located in the Shamakhi district of Azerbaijan. This park not only preserves natural wealth and biodiversity but also plays a role in promoting the social participation of the local community and visitors. In this paper, the role of Shamakhi Safari Park in social participation will be discussed and the contribution of the community around the park to sustainable tourism will be examined. The involvement of the local community is critical to the successful operation and sustainability of Shamakhi Safari Park. Community participation involves the active involvement of local people in park management and decision-making processes. This ensures that the park's policies, activities, and projects are relevant to the needs of the wider community. The park can lead projects that aim to increase the environmental responsibility of society, such as environmental projects and recycling programs. Such projects can have an impact on minimizing the park's impact on the environment and making visitors aware of environmental issues. The management model of Shamakhi Safari Park should be a participative structure to receive the views of the local community on the functioning and future of the park. Community trust and commitment to the park are critical to long-term sustainability. As a result, Shamakhi Safari Park can strengthen the goal of natural resource conservation as part of sustainable tourism by encouraging social participation. The management of the park can create an interactive and sustainable tourism model, taking into account the views and needs of the local community. The park can lead projects that aim to increase the environmental responsibility of society, such as environmental projects and recycling programs. Such projects can have an impact on minimizing the park's impact on the environment and making visitors aware of environmental issues. The management model of Shamakhi Safari Park should be a participative structure to receive the views of the local community on the functioning and future of the park. Community trust and commitment to the park are critical to long-term sustainability. Shamakhi Safari Park can strengthen the goal of natural resource conservation as part of sustainable tourism by encouraging social participation. The management of the park can create an interactive and sustainable tourism model, taking into account the views and needs of the local community. Eco-tourism should be evaluated in terms of its positive effects on the local economy, job opportunities, and opportunities for local entrepreneurs. Shamakhi Safari Park stands out as a tourist destination that not only preserves natural wealth and biodiversity but also contributes significantly to the local economy. In this paper, Shamakhi Safari Park's contributions to the local economy will be examined in detail and its effects on local businesses, employment opportunities, and economic growth under the influence of the park will be evaluated. Shamakhi Safari Park provides employment opportunities to local people by creating several job opportunities in the region. Local people who are employed in various sectors such as tour guides, maintenance staff, security guards, and souvenir sales personnel make a living thanks to the activities of the park. Safari Park can support the sale of local products by establishing cooperation with local entrepreneurs in the region. The park's visitor traffic can contribute to local economic growth by creating a potential customer base for surrounding restaurants, cafes, and souvenir businesses. Spending by tourists visiting the park can stimulate the local economy in the region. Expenditures for

accommodation, dining, shopping, and other tourist activities can increase the income of businesses in the region and promote economic diversity. Shamakhi Safari Park can provide training opportunities for people who will be employed in the park's operation and tourist service sector by organizing training and skill development programs for local people. This can increase the chances of employment by increasing the skills of local people in the tourism sector. The park can contribute to the strengthening of the regional economy by supporting the supply of local raw materials and materials for business needs. Cooperation with local suppliers can increase local production and economic sustainability. Social and cultural interaction between tourists and local people can increase the park's contribution to the local economy. Local handicrafts, traditional food, and cultural activities can support local entrepreneurship and trade by attracting tourists to the region. Shamakhi Safari Park supports the development of the region by making positive contributions to the local economy in line with the principles of sustainable tourism. Factors such as the strengthening of local businesses, the increase in employment, and the retention of touristic expenditures in the region emphasize the impact of the park on the economic well-being of the local community, beyond being just a nature reserve.

RESULTS AND DISCUSSION

This scientific paper was prepared to evaluate (Aerospace Map, 2025; 2023; Mammadova, 2023; Wild Farm for Alpacas, 2025) and propose sustainable tourism strategies. A structured comparison between the Shamakhi geoglyphs and those located in regions such as Peru, Saudi Arabia, and Kazakhstan would provide valuable insights. This analysis should focus on similarities and differences in morphology, including shapes, sizes, and design patterns. Additionally, examining the potential functions—such as ceremonial use, territorial marking, or astronomical alignment—could clarify their cultural significance. Considering the environmental and historical context of each site would further enhance understanding of the origins and purposes of these geoglyphs.

The region can be center of sustainable tourism with its biodiversity, ecosystems, and social participation. However, to realize this potential, protection of natural resources (Mammadova, 2021; Mammadova, 2022; San Diego Zoo Global Science, 2020), of local communities, and conscious tourism practices (Mammadova, 2023) are necessary.

Ecosystem protection projects and rehabilitation efforts include:

- Vegetation and water resources management;
- Protection and rehabilitation of local flora and fauna species.

As for Social Participation and Education Strategies, some action plans are planned to be implemented in the following order. The park focuses on the following strategies to promote the participation of local people and visitors in sustainable tourism.

Many measures are implemented in environmental education programs and activities:

- Ensuring the participation of the local community in tourism planning and management;
- Informational materials and guidance to visitors about their environmental responsibilities.
- Shamakhi Safari Park focuses on the following strategies to positively impact the local economy:
- Collaborations promoting local products and crafts;
- Joint projects and collaborations with local businesses;
- Directly directing tourist expenditures to the local economy.

The following are the strategies adopted by the park to minimize its environmental impact:

- Waste management and recycling programs;
- Water and energy saving applications;
- Efforts to reduce carbon footprint and use of green energy.

Sustainable tourism focuses on the following strategies to regulate tourist flows and reduce environmental impact:

- Control of the number of visitors and limited access;
- Promotion of public transport and environmentally friendly transport options;
- Regulation of activities with the risk of harming natural areas.

Summarizing the paper, the comparative water temperature graph was defined for the neighboring districts around the research area including Ismayilli, Agsu, and Gobustan which is very necessary to develop the tourism sector here.

The graph in Figure 12 shows that in hot periods in four seasons, Aqua-basin tourism is possible around Safari Park, too, water temperature lets the visitors to come Shamakhi district. Maximum water temperature in Shamakhi and Ismayilli contest of 31°C (Climate condition of Safari Park, 2025; Mammadova, 2022). Thus, both districts are close neighbors, there is 16.12 km distance between Shamakhi Safari Park and the well-known Lahij (Ismayilli), and it takes

15-20 minutes in a car for tourists. So, the research object is bordered by interesting places attracting visitors and tourists. By the way, unlike Ismayilli and Shamakhi the rest districts, Aghsu and Gobustan have got higher data. As a result, Shamakhi Safari Park combines efforts to protect natural resources (San Diego Zoo Global, 2023), promote social participation, contribute to the local economy, and minimize environmental impact by adopting sustainable tourism strategies. These strategies play an important role in ensuring the long-term sustainability of the park and making a positive impact on regional development.

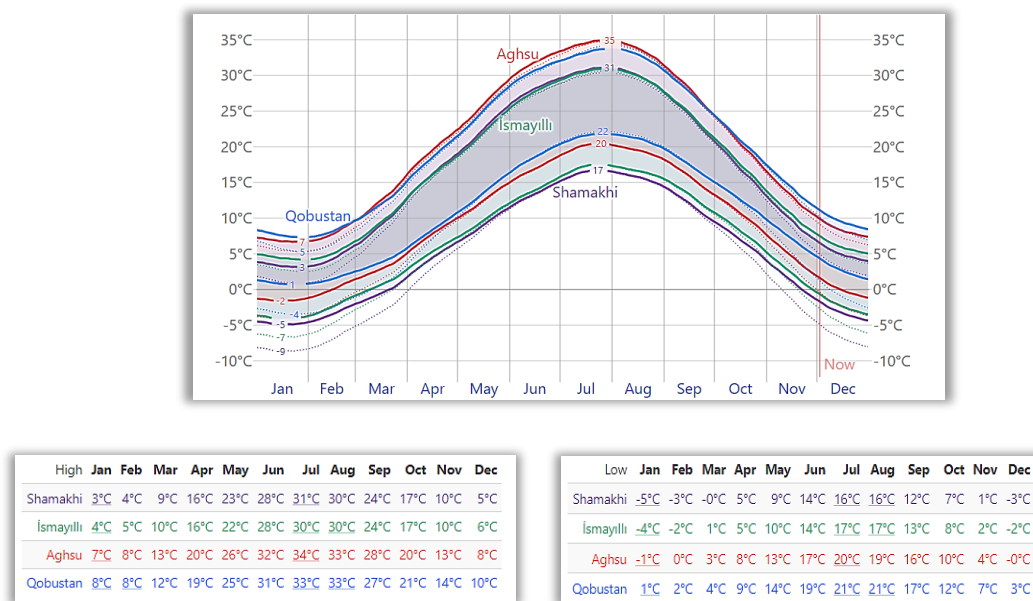


Figure 12. Comparative water temperature difference between 4 districts in 2017- 2022.

CONCLUSION

In summary, Shamakhi Safari Park emerges as a focal point for the convergence of biodiversity conservation, sustainability, and community engagement, positioning it as a promising center for ecotourism. The harmonious integration of these components not only guarantees the safeguarding of the park's ecological treasures but also nurtures a mutually beneficial relationship among nature, tourism, and local communities. Through meticulous planning and an unwavering dedication to best practices, Shamakhi Safari Park has the potential to exemplify a successful and responsible model for ecotourism for all seasons.

AUTHOR'S CONTRIBUTION

Ulviyya Mammadova conceived and designed the study, and wrote the main manuscript text based on observations and analysis of activities

FUNDING

No funding was received for the present study.

AVAILABILITY OF DATA AND MATERIAL

The datasets supporting this study are included in the article. Extended methodological details and raw data can be accessed by contacting the corresponding author, subject to ethical and institutional guidelines.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

The author declares no conflict of interest.

ACKNOWLEDGEMENT

The main purpose of the paper is to open this beauty to the World for attracting visitors and developing the tourism sector here perfectly.

REFERENCES

- Aerospace Map. (2025). <https://www.openstreetmap.org/edit#map=16/40.8150/48.5744>
- Climate condition of Safari Park, (2025): <https://weatherspark.com/y/104651/Average-Weather-in-Shamakhi-Azerbaijan-Year-Round>
https://beu.edu.az/root_panel/upload/files/beu_edu_az/journals/2023_1/chemistry_1.pdf#page=5
- Mammadova, U. F. (2021). Crude oil contaminated soils' actual ecological recultivation ways. *Processes of Petrochemistry and Oil Refining*, 22(2).
- Mammadova U.F. (2022). Ecological monitoring of Chukhuryurd Lake' Ecotourism potential. *Aswan University Journal of Environmental Studies (AUJES)*, Egypt, 1 (1), 38-47
- Mammadova U.F. (2023). Effect of humic substances on yield and nutrient contents of Eggplant Santana (*Solanum melongena*) plants in gray-brown soil. *Eurasian Journal of Soil Science*, 11(4), 98-103:
- Mammadova U.F. (2021). Efficiency of solar energy application for stopping deforestation. *Thermam International Conference Rostock, Germany*, 9 (10), 46:
- Mammadova U.F. (2022). *Environmental Aspects of Using Renewable Energy Sources in Forest Conservation*, Baki, "MSV" Publication, 220 p: ISBN 978-9952-37-890-0;
- Mammadova U.F. (2023). Garanohur Lake' Ecotourism Potential Study (Ismayilli District). *Journal of Baku Engineering University. Chemistry and Biology*, 25 (1), 3-10:
- Mammadova U. (2022). Remote Sensing Based Study on Wind Energy's Ecological Effectiveness in Shamakhi District (Azerbaijan). *Aswan University Journal of Environmental Studies*, 3 (1), 1-8:
- Mammadova U.F. (2022). Remote sensing climate monitoring for wind potential to reduce deforested areas of Mountainous Shirvan. *Proceedings of The Virtual International Conference "Current Problems of Modern Agricultural and Biological Sciences: Global Challenges and Innovations"*, 1 (1), 360-366:
- Mammadova U.F. (2023). Remote Sensing Study of Wind Energy Potential in Agsu District. *ICEFSSS*, 1(1), 425-43: http://www.fesss.org/upload_pic/2d7f039f022fd4d1920edfce0370cc66.pdf#page=42
- Mammadova U.F. (2022). The effect of bio-humus on Cardinal grape yield (*Vitis vinifera* L.) and nutrient contents of dark brown soil using drip irrigation systems under the open field conditions. *Eurasian Journal of Soil Science*. 11 (4), 345-352:
- Mammadova U.F. (2022). Wind Damages Monitoring on Vine Yard to Select the Right Location in Gobustan District. *The International Symposium on "Soil Science and Plant Nutrition"*, 7 (1), 175-179:
- Mammadova U.F. (2022). Wind Energy Potential Estimation in Agsu District. *"Mathematics and Natural Sciences" Series of the Periodical Scientific Journal "News of the Pedagogical University"*, 70 (46), 39-46:
- Mammadova U.F. (2022). Woodland Soils Alternative Protection Ways. *Journal of Baku Engineering University Chemistry and Biology*, 25, 6 (1), 31-41:
- Mammadova U.F. (2022). Wind Energy Potential's Remote Sensing Study to Save Bioenergy Resources in Highest Mountainous Regions. *II International Scientific-Practical Conference "Reconstruction and Restoration in Post-Conflict Situations"*. Azerbaijan, Baku, 24 (2), 100-105.
- Mammadova, U.F. (2022). Study of Wind Erosion Risk by Remote Sensing on Chestnut Soils. *Bulletin of the Ryazan State Agrotechnological University named after P.A. Kostychev*, 14 (2), 65–71.:
- San Diego Zoo Global Science. (2020). Drone-based habitat mapping at San Diego Zoo Safari Park. *Science Blog*: <https://science.sandiegozoo.org/science-blog/drone-based-habitat-mapping-takes-San-Diego-Zoo-Global>. San Diego Zoo Safari Park Biodiversity Reserve, 2023: <https://science.sandiegozoo.org/resources/safari-park-biodiversity-reserve>.
- Shamakhi Safari Park. (2025). Animals and Daily Routine. https://www.instagram.com/safari_park_shamakhi/
- Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E., & Steininger, M. (2003). Remote sensing for biodiversity science and conservation. *Trends in ecology & evolution*, 18(6), 306-314.
- Yulianto S. et al., (2023). Reduction of Carbon Emissions from Tropical Peat Land Fire Disasters Using Weather Modification Technology. *Ecology and Environment Journal*, 11 (5), 834 – 848: