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Wildfire hazard and risk assessment: The case of Gabala district

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Abstract

As one of the main natural resources for humans, protection of forest resources is one of the main ecological problems of the world. Forests are a source of oxygen, as well as they have some features that can ensure ecological balance. For example, forests are one of the major factors that prevent landslides, erosion processes, flood events, as well as protecting land resources, hydrological resources and optimization micro climatic condition. Decreasing of forest stock affects the fauna directly. There are some factors that impact decreasing of forest resources, for example, settlements, industry and forest supply and etcetera. Forest fires occurring in different parts of the world every year eradicated acres of forest stock. The formation of forest fires is influenced by factors such as climate, anthropogenic and topological effects. Research area is district of Gabala, which is situated at south slopes of Greater Caucasus. Gabala is distinguished by the abundance of forest resources in the territory of Azerbaijan, which is poorly provided with forest reserves. 32405.15 hectares of this district are covered with forests. Taking into account that 40% of the fire incidents that occurred on the southern slope of the Greater Caucasus in 2021 and 2022 took place here, this place was taken as a research area. Wildfire hazard and risk assessment and fire risk zonation, anthropogenic and topological effects are considered in this article and mapping had been done. The resulting values were classified according to the risk group and the results were compared with the fire area data. As a result of the comparison, was not found fire process in the categories of no risk or low risk. 90% of fire incidents could be classified as medium risk, high risk and critic high-risk categories. Consequently, this is an indicator of the validity of the selected parameters and the conducted assessment.

1. Introduction

Forest ecosystems, which we can describe as our lungs, are 4 billion hectares covering 1/3 of the world and constitute 75% of biological diversity. Forests have many functions that are extremely vital for the survival of living things, such as maintaining the balance of the climate, protecting soil, water and biological diversity. However, these functions are threatened by factors that put the continuity and sustainability of the forest at risk, such as diseases, insect invasions, drought, unplanned settlements and occupation of the forest by agricultural practices. Among these factors, forest fires are seen as one of the most important damaging factors (Atan et al., 2020; Bar et al., 2020; Kuter et al., 2011). Forest fires affect thousands of hectares each year and cause dramatic changes in forest ecosystems (Başkent, 2018; Başaran et al., 2004; Goldammer & Mutch, 2001;). Approximately 4,000,000 hectares of forest area are damaged in fires in the world every year (Versini, et al., 2013).

One of the most important issues in pre-fire planning is to determine the risk and danger of fire in advance and to take the necessary precautions for sensitive areas. In this respect, the creation of wildfire hazard and risk assessment, fire risk and danger maps is an important base in preventing fire disaster and damage caused by fire (Dong et al., 2006). Generally, forest fire management consists of four steps: mapping fire risk and hazard, monitoring active fires, identifying fire-sensitive areas, and identifying post-fire deterioration (Betanzos et al., , 2003; Roy & Dun, 2003 Jaiswal et al., 2002).

Here, the first step of the fire management system is fire risk mapping, by analyzing the factors that cause forest fires, predicting fire risk and thus preventing fires and fires damage. For this reason, the creation of forest fire risk and hazard maps constitutes an important basis for preventing fire disaster and damage caused by fire. Pre-fire mapping of fire-sensitive areas, taking necessary precautions in areas with high fire risk , the deployment of first responders, especially in areas that are sensitive to fire at the first degree, facilitates the access of fire crews to the fire as soon as possible by using the shortest and safest way and makes it possible to create the necessary bases for firefighting.

In order to create fire risk maps, it is necessary to reveal and examine the factors that are effective in

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forest fires. This makes it necessary to evaluate natural and anthropogenic factors together. Land cover especially vegetation represents the combustible material necessary for the emergence and development of fires. The slope factor in natural factors (vegetation, topography) also has an important effect.

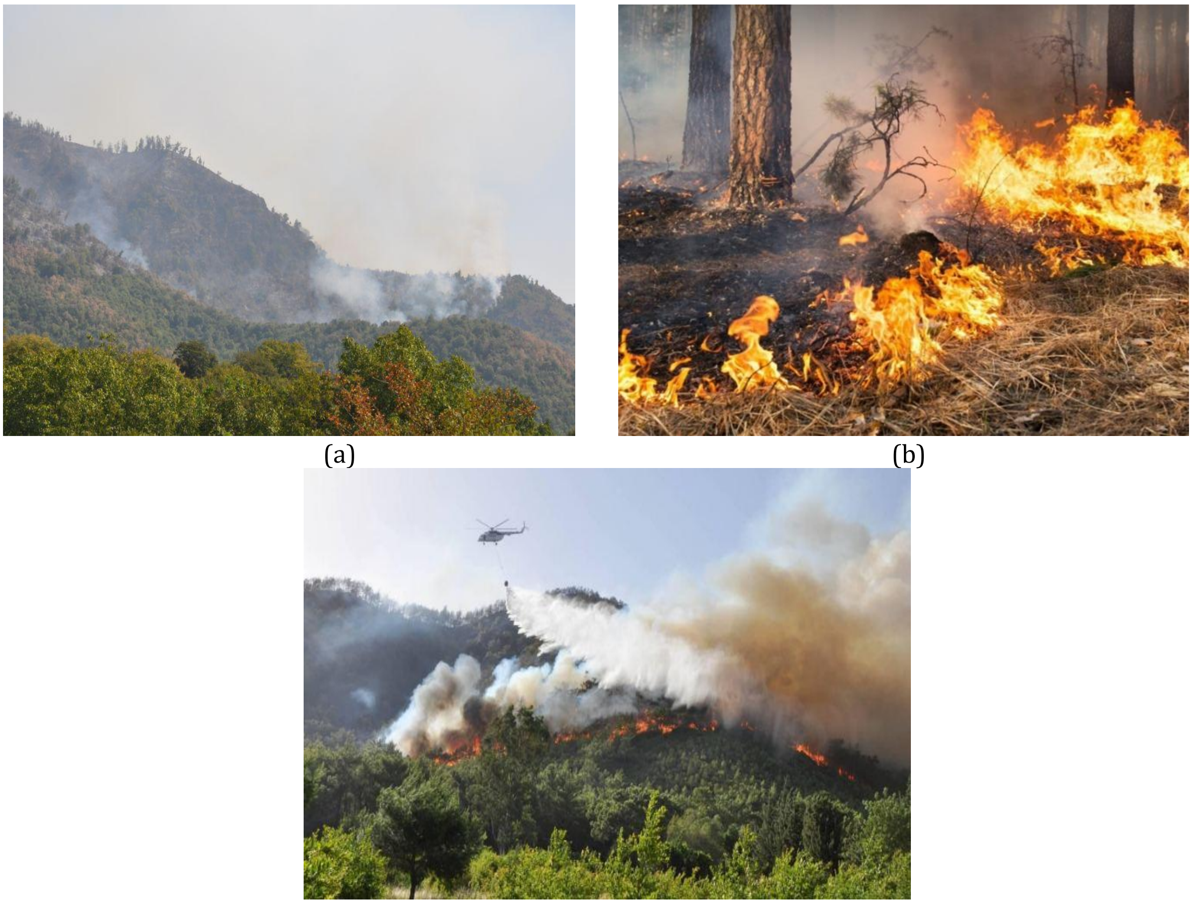
In forest fires, the flames can easily reach the areas here by moving rapidly up the slope.Aspect is also one of the important parameters affecting the spread of fires. Generally, south-facing slopes are more susceptible to forest fires than other slopes . Anthropogenic factors, on the other hand, can be explained as the spatial distribution of certain infrastructure facilities used by people such as roads and residential areas, and these factors also affect forest fires . Due to the human factor, the probability of fire in places close to settlements is high.

The main purpose of this article as a result of the created fire risk maps, to contribute to the effective fight against fire by identifying in advance the areas with a high risk of fire and having knowledge about fire behavior.

Research area is located South slopes of Great Caucasus and Qanıx-Ayricay valley. Qabala is old district of azerbaijan. The region is located at an altitude of 68-4466 m. It covers an area of 1,548,600 ha. Forest area occupies 21% of the territory. Fauna and flora species included in the red book of Azerbaijan are spread in the area. Azerbaijan is a country with few forest resources. Forests covered 11% of the country's total area. The south slope of the Greater Caucasus stands out in the country for its percentage of forests (40% of the area) (Məmmədov & Xəlilov, 2022). On the South slopes of Great Caucasus, which is well provided with forest resources, nature protection is considered one of the urgent issues. 45 percent of the territory is occupied by Specially Protected Nature Areas. There are a part of the Shahdag National Park, Gabala and Turyanchay nature reserves, 28 biological nature monuments and specially important forest areas taken under state control in the territory of Gabala region. Despite this, 40% of the fires that occurred on the south slopes of the Greater Caucasus in 2021 and 2022 fall on the territory of Gabala region. During the research period, 1826.3 ha of forest area was burned. This is 5.64% of the total forest area of the district. During the research period, 1826.3 ha of forest area was burned. This is 5.64% of the total forest area of the district. 2021 and 2022 were taken as research years. Wildfire hazard and risk assessment and fire risk zonation of Gabala district was carried out taking into account factors such as anthropogenic and effects of topography. In order to assessment the obtained result, it was compared with the fire data of recent years and the areas covered by the fire.

2. Method

Remote Sensing data programs and ArcGIS map 10.8 Software were used for fire risk assessment in Gabala region during the research (Figure 1).



(a) (b) (c)

Figure 1. (a) Gabala district, (b) Gabala district, Solquca village, (c) Gabala district, Tikanlı village

Effects of topography (slope, elevation, aspect) and anthropogenic parameters were taken as criteria. when assessing the fire risk of the area, it is divided into 5 categories; no risk; low risk; medium risk; high risk; critical risk. Here, the slope, elevation, aspect and land use and land cover (LuLc) parameters were reclassified .Then overlay and map algebra operations were performed. Using this information, a fire risk assessment and risk zonation map was created. 30 m resolution SRTM DEM data provided by NASA, USGS were used to study Aspect, Slope and Elevation parameters. To investigate the land use and land cover parameters, the "Landsat 8" data provided by USGS Earth Explorer dated 17.07.2022 was used.

The following steps were taken to create the wildfire hazard risk assessment and zonation map:

- The Aspect layer has been created (Aspect).
- The Aspect layer has been reclassified (Reclassify).
- The Slope layer has been created (Slope).
- The Slope layer has been reclassified (Reclassify).
- The Elevation layer has been created (Elevation).
- The Elevation layer has been reclassified (Reclassify).
- Land use and land cover layer has been created (LULC).
- Land use and land cover layer has been (Reclassify).
- Performed overlay and map algebra operations using elevation, slope, aspect and land use and land cover reclassification layers and was created wildfire risk assessment and zonation layer.
- Wildfire risk assessment and zonation layer has been reclassified.
- Wildfire risk assessment and zonation layer has been converted to a Polygon Layer (Raster to Polygon).
- Wildfire risk assessment and zonation map has been created.
- Wildfire risk assessment and zonation layer has been converted to a Polygon Layer (Raster to Polygon).
- Wildfire risk assessment and zonation map has been created.

Data on wildfires and burned agricultural residues were obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS), a satellite-based sensor. Information about Forest and agricultural resudes active fire location data was taken "NASA FIRMS" application, which is, uses different type of satellite-based sensor (Landsat, VIRS (S-NPP & NOAA 20), MODIS (Aqua & TERRA). Using in this data was created wildfire burned area and active wildfire location map and graphs. In addition, using the existing stock literature materials, information on climate was investigated and certain results were obtained.

3. Results

Based on the effects of topography (slope, aspect, elevation) and Land use and Land cover parameters of the study area, fire risk classification was carried out (Table 1). A fire risk assessment and a zonation map were drawn up according to the obtained categories. As a result, based on the obtained values, overlay and map algebra operations were performed, and the WildFire Assessment and Zonation map was drawn up and the area of the areas included in the risk categories was calculated (Figure 2).

Table 1. Wildfire risk assessment criteria

Risk assessment	Aspect (°)	Slope (°)	Elevation (m)	LuLc
No risk	0-45 315-360	0-8	3500-4466	Water bodies, bare earth, bare soil
Low risk	45-90, 270-315	8-15	3000-3500	Selitep areas
Moderate risk	90-135	15-25	68-500	Agricultur e land
High risk	135-180 225-270	25-35	2000-3000	Pasture
Critic risk	180-225	35-68	500-2000	Forest

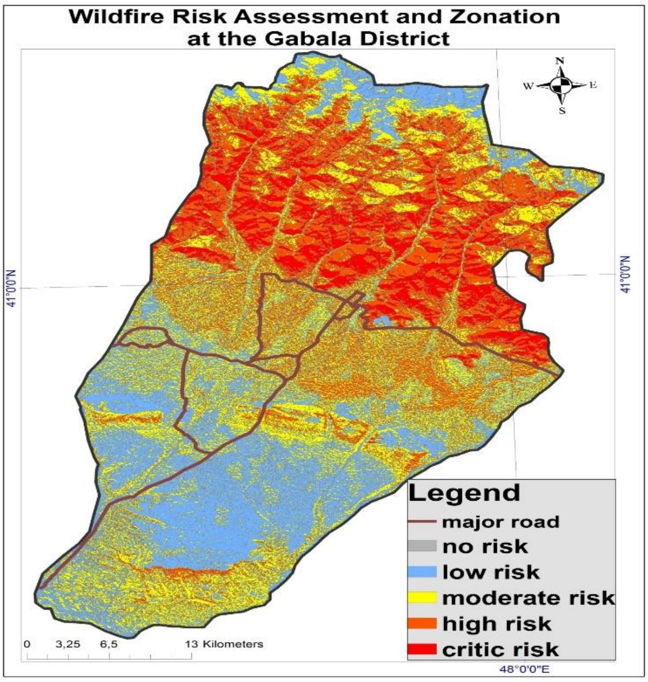


Figure 2. Wildfire risk assessment and zonation

In general, 0.43% of the territory corresponds to no risk, 28.24% to low risk, 35.01% to moderate risk, 24.48% to high risk, and 10.84% to critical risk classification (Figure 3).

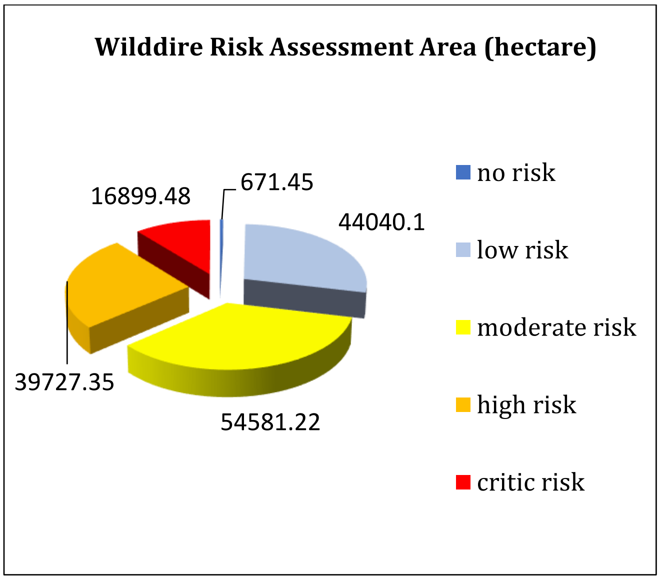


Figure 3. Wildfire risk assessment area (hectare)

The resulting values were classified according to the risk group and the results were compared with the fire area data. In total, 108 fire incidents occurred in the area in 2021 and 11 in 2022 year. As a result of the comparison, no fire process was found in the non-risky area. There were 2 fire incidents in the low risk category, 10 in the moderate risk category and 107 in the high and critical risk categories. Thus, we can see that 90% of fire incidents correspond to the high risk and critical risk category (Figure 4).

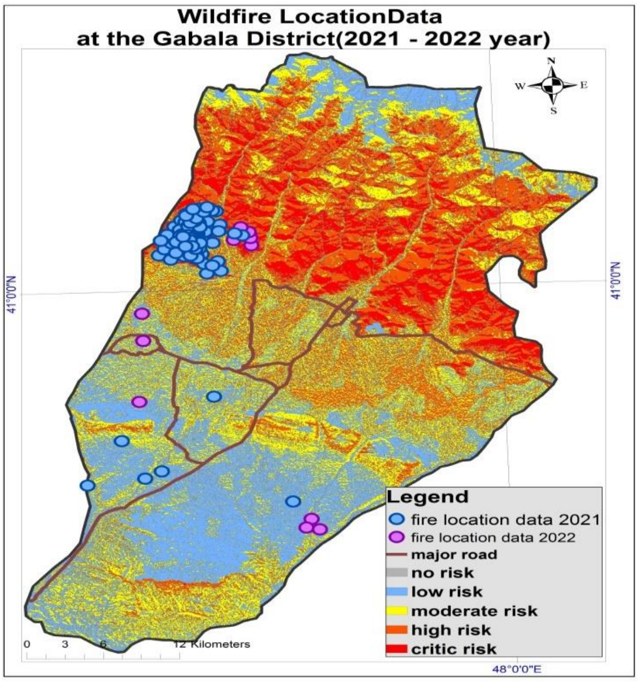


Figure 4. Wildfire location data (2021-2022 year)

When the obtained results are compared with the fire area data, we can see that 100% of the area corresponds to the high risk and critical risk category. In general, during the study period, it was determined that 5.4% of the forest resources were destroyed based on the fire area data (Figure 5).

It is extremely important to be able to predict the potential fire risk and fire hazard of a region in forest fire fighting studies. In this way, potential areas with high fire risk and danger will be given priority in pre-fire planning, and protective and preventive measures will be handled more comprehensively in these areas. In this context, making the area safer in terms of forest fires by reducing the risk and danger of fire will be possible. Similarly, in order to effectively fight possible fires, these areas where the fire risk and danger are high should be given priority in the deployment, management and administration of resources and teams.

In these results, it is an indication that the selected parameters and the evaluation are reasonable.

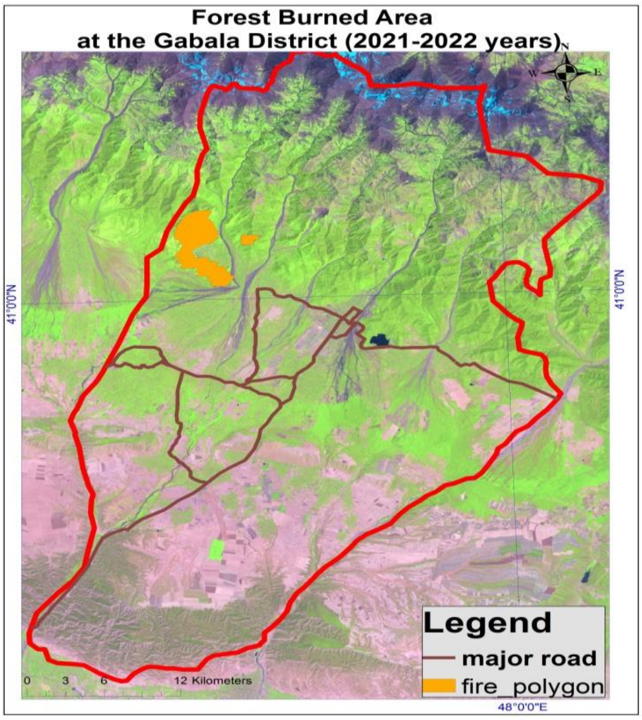


Figure 5. Forest burned area (2021-2022 year)

4. Discussion

As one of the main natural resources for humans, protection of forest resources is one of the main ecological problems of the world. Forests are a source of oxygen, as well as they have some features that can ensure ecological balance. For example, forests are one of the major factors that prevent landslides, erosion processes, flood events, as well as protecting land resources, hydrological resources and optimization micro climatic condition. Decreasing of forest stock affects the fauna directly. There are some factors that impact decreasing of forest resources, for example, settlements, industry and forest supply and etcetera. Forest fires occurring in different parts of the world every year eradicated acres of forest stock. Willdfires formed in 3 different ways.

- Cover fire
- Hill fire
- Ground fire

Cover fire; It is produced by the burning of needles, branches, cutting residues, grass, heather and live cover on the forest floor. It rarely harms the native tree species of the forest. When the weather is humid and in the winter months, it turns into hill fires.

Hill fire: Damages the entire forest, especially the original tree species in the forest. It is a type of fire that burns the tops of trees. When we say hill fire, it should be understood that all the elements in the forest, including the substances on the soil surface, are burned.

Ground fire: Fires that occur in peat above and below (the root part) of forest soil, such as marshes and bogs.

Wildfires that have been in Gabala district area are basically suitable for the 1st group. Here, wildfire, which are characterized as hill fire, also occur. But wildfires such as ground fire do not occur here.

On 16.08.2021 and 26.08.2021 Solguca, on 08.08.2021 and 03.04.2022 in Vandam, on 16.08.2022 Abrikh and Tikanlı, on 01.09.2022 in Tikanlı the mountain forest area near the can be attributed to group 1 forest fires (Figure 6). During the incident, dry grass, bushes, dried tree stumps and some trees burned in the forest area.

On 11.08.2021, the forest fire that started on the Kyzylburun mountain near Tikanlı village spread to the territory of the Ganjadash mountain under the influence of strong wind and covered an area of more than 50 ha. It also destroyed dry grass, bushes, dry trees, their remains and trees. . This fire can be attributed to the ground fire type.

On 04.09.2021, the forest fires that lasted for more than 20 days near the villages of Solguca, Dandikh, Abrikh and Tikanli spread to the territory of the Shahdag National Park. The forest fire that happened here can be attributed to the 2nd group according to its nature.

In total, 1826.3 ha of forest area was burned during 2021 and 2022. Forest restoration works have been carried out in these areas.

A partial middle and high zone of forests in Gabala District is included in the territory of Shahdag National Park. Any interference in the national park territory is prohibited according to the regulations of specially protected natural areas.For this reason, dry trees in the territory of the National Park are not touched. Dry firewood increases the likelihood of transition from a surface fire to a hill fire. Given that the area is included in the critical risk classification, dead trees and their remains are likely to exacerbate the danger during a fire. In this regard, in the last 3 years, the process of collecting dead trees in the territory of the National Park has been started.

The formation of forest fires is influenced by factors such as climate, anthropogenic and topological effects. Research area is district of Gabala which is situated at south slopes of Greater Caucasus. Gabala is distinguished by the abundance of forest resources in the territory of Azerbaijan, which is poorly provided with forest reserves. In the north of Gabala, alpine and subalpine meadows, mountain forests, bushy and sparsely wooded meadows in the central part, and wormwood and wormwood-saline semi-desert plants, xerophytic sparse forests occupy a large area. It is an area with high tourism potential. It has a dense river network system (Türyan, Demiraparan and their tributaries Tikanlıchay, Bum, Vandam, etc.).

When assessing the occurrence and spread of forest fires, it is important to consider parameters such as climate, anthropogenic and effects of topography. In this article, the classification was made mainly based on anthropogenic and relief factors. The following table lists the parameters of the classification and the results of research conducted based on these parameters in the area.

Table 2. Areas calculated based on wildfire risk assessment criteria (area values hectare)

Risk assessment	Aspect area	Slope area	Eleva-tion area	LuLc cover area
No risk	3414.90	74666.70	2032.70	20802.20
Low risk	395550.70	19792.90	6413.82	32495.19
Moderate risk	15961.10	24991.20	58011.60	24395.95
High risk	47370.80	25011.10	12593.30	46371.68
Critic risk	28897.60	11459.80	42198.30	32405.15

Climate factor. The climate is mild-warm with dry winters in the lower part, and cold and humid in the highlands. Annual precipitation is 500-600 mm in the lower part, up to 1600 mm in the highlands. Average monthly temperature decreases with increasing altitude. While the average temperature in July is 24-27 C° in the plain part of the region, it drops to 20-15 C° in the middle highlands, and 10-5 C° in the highlands. While the average January temperature is 2 C° in the plains, it drops from -10-(-11) C° to even -14-(-15) C° in the high mountain peaks. Taking into account climate parameters (temperature and humidity), the risk of fire decreases with increasing altitude. The increase in temperature in the summer months and the partial decrease in precipitation increase the risk of fire. During the research period, according to the data we took from the "NASA FIRMS" platform, it can be seen that 93.27% of fire incidents happened in the summer months (August, early September). It should be noted that the fire events that occurred in September coincided with the first 5 days of the month (Müseyibov, 1998).

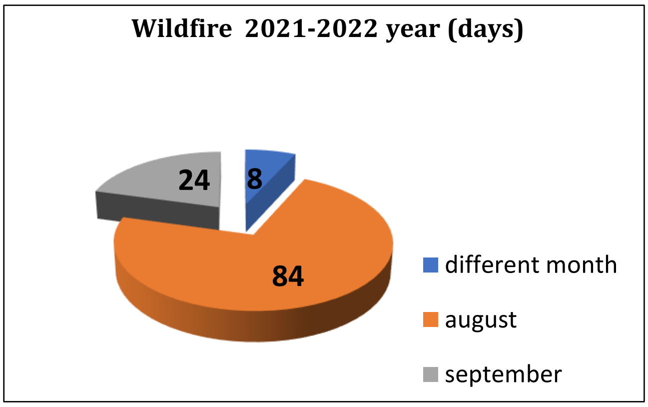


Figure 6. Wildfire events 2021-2022 year (days)

The causes of fires are mainly to combine under 3 groups: unknown, natural and anthropogenic factors.

1-Unknown:

These are fires whose origin is unknown.

2-Natural Fire:

These are fires that occur without any human factor. These are fires that started due to lightning, volcanic activities and gas emissions.

Lightning: Fires caused by lightning strikes.

Volcanic activities: These are fires originating from volcanoes.

Gas Emission: These are fires that occur spontaneously as a result of the compression of gases. Spontaneous ignition of underground mines and burning of garbage cause forest fires.

3- Anthropogenic factors are one of the main factors we should pay attention to when assessing fire risk. A number of anthropogenic effects, which we have listed below, cause forest fires.

- carelessness, negligence and intentional burning.
- making campfires in the forest without observing safety rules
- Throwing unextinguished cigarette butts and matches on the ground
- throwing glass and broken glass into the forest
- stubble burning
- intentional fires

The distance from residential areas and highways was taken into account when assessing the risk. Looking at the map of highways in Figure 3, it is clear that most of the fires classified as moderate risk occur in the buffer zone of 2000 m, which is defined as a risk area. (Figure 7).

The fires in Gabala are mainly anthropogenic in nature. The main cause of anthropogenic forest fires are careless and intentional fires. Fires caused by carelessness have increased in recent times in connection with the rapid development of tourism in Gabala region. The increase in the number of tourists in the area, their use of forests without complying with safety rules, causes fires. Unextinguished cigarette butts are thrown into the forest, barbecues are left in the forest area, bonfires are left in picnic areas, and bright materials are thrown into the forest due to carelessness.

Attributing the following to other fires caused by negligence:

- vegetation management: Non-agricultural vegetation management fires caused by unintentional burning.
- Agricultural Activities: Plant wastes (Example stubble) fires caused by burning.
- Waste management (dump): Official or illegal dumping of waste fires caused by burning.

Forest fund territories are bordered by municipally owned lands and farms. Burning of stubbles after grain harvesting, careless handling of fire in pastures (the road to pastures passes through the territory of the forest fund) and other similar cases eventually lead to the spread of fires to forests.

The reason for the fire that occurred near Yenikend village on 03.04.2022 is that the fire spread to the forest area during the burning of garbage in the backyard of the villager.

Another cause of forest fires that occur in the area of Gabala is intentional. There are 3 settlements and 60 villages in the territory of Qabala district, of which 29 villages are not gassed. In winter, the population's demand for fuel leads to the use of forest resources as firewood. Since the wood is mainly grown in Azerbaijan, the broccolis burn the trees that are cut down to hide their activities. Some of these activities are observed more intensively in the regions of Tikani, Abrix, Solquca and Dandıq, which are not yet fully met. 89% of the oak burns that broke out in 2021-2022 occurred in these areas.: Fires caused by the deliberate burning of forests by people.

- Responsible: These are forest fires started by people over the legal age limit. These fires are examined in seven subgroups.
- Annuity: The reason for exit is to earn money or another way.
- forest fires for the purpose of.(Trench)
- Dispute: The reason for the exit is the fires that were started to take revenge and revenge.
- Vandalism: Malicious mischief and deliberate fires by people with personality disorders.
- Excitement: a sense of people feeling important
- caused by fires.
- Crime concealment: The reason for the fire is to hide a criminal activity.
- Extremism: Fires started for social, political or religious reasons

Intentional wildfire are made in the Gabala district. In Gabala district, there are 28 villages that are not supplied with gas. The cold winter and the population's demand for fuel lead to the use of forest resources as firewood. Since the forests is mainly protected in Azerbaijan, the broccolis burn the area which is trees that are cut down to hide their activities. Some of these activities are observed more intensively in the regions of Tikani, Abrix, Solquca and Dandıq, which are not supplied with gas. 89% of the wildfire that broke out in 2021-2022 occurred in these areas.

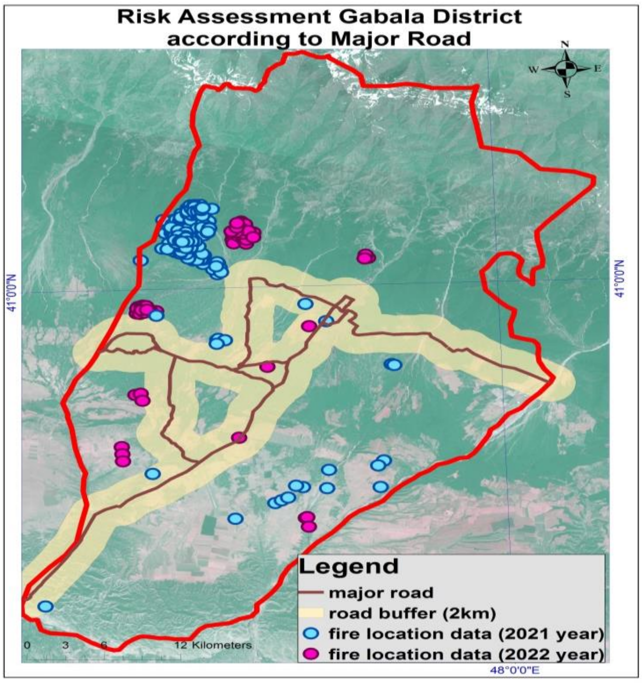


Figure 7. Risk Assessment according to major road.

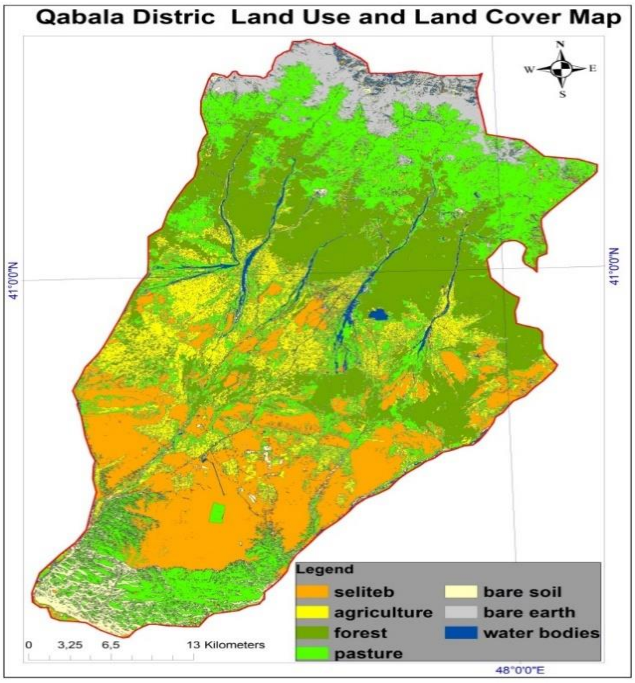


Figure 8. Land use and land cover

The settlement factor was taken into account during the research. After the 2000s, the rapid development of tourism in the region has led to an increase in anthropogenic loads in the area. Resort-recreation centers created in the forest area increase the risk of forest fires of anthropogenic origin. As we can see in Figure 8, the central part of the area (200-800 m) is more densely populated. This corresponds to the lower border of the forest. Settlements exist in the middle forest (800-1200 m) zone.

The map was prepared using arcgis 10.8 software from Landsat 8 data dated 17.07.2022 provided by USGS EarthExplorer. At this time, forest, agriculture land, urban areas, pastures, bare soil and earth land areas were classified using 1, 2, 3, 4, 5, 6, 7 band combinations and a land use and land cover map was drawn up. The resulting values were classified according to the risk group. The forest area of the total area is 20.71%. Settlement and appropriated areas cover 36.36%, summer and winter pastures cover 29.64%. In general, it is classified as water bodies, bare earth and soil land no risk, selteps low risk, agricultural area medium risk, pastures high risk, forest critical risk. In Figure 8, the Land use and Land cover map of the area was drawn up, then fire risk classification was made based on it (Figure 9).

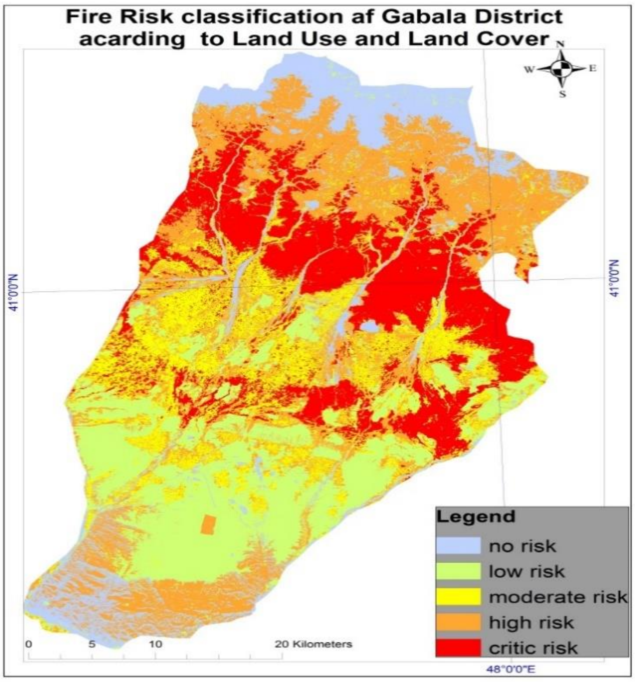


Figure 9. Fire risk classification acording to land use and land cover

Elevation, slope and aspect parameters of the area are the main relief features that affect the risk of forest fires (Castro & Chuvieco, 1998; Chuvieco & Salas, 1996). It provides important information about the determination of the fire area, the speed and direction of its spread. Assuming other risk factors are constant, fire will move fastest on steep slopes. That said, increased inclination also increases the risk of fire.

The territory of Gabala district has an inclination interval of 7° - 68°. The inclination increases from south to north. 5 classifications were used when assessing forest fire risk based on slope inclination: 0-8° no risk, 8-15° low risk, 15-25° medium risk, 25-35° high risk and 35-68° critical risk areas. 47.9% of the total area of the territory is classified as no risk, and 23.4% as high and critical risk (Figure 10).

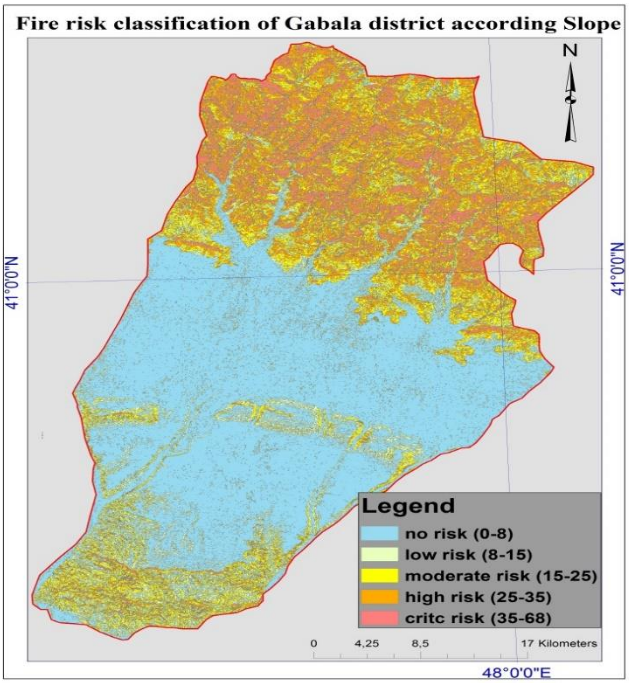


Figure 10. Fire risk classification according slope

Although the angle is fixed, the received solar radiation varies according to the position of the sun. Therefore, the strong influence of sun exposure on fire behavior varies throughout the day. The amount and type of fuels available varies greatly by tank.

North slope: Compared to other slope, the sunbathing time is less. It is advantageous in terms of fires. However, the humus layer is thicker.

South slope: They spend a long time in the sun, they are exposed to higher temperatures during the day. Eastern slopes: slopes are the first to receive the sun during the day. It is less sensitive than the south and west. Western slopes After South slope, they have the most sunshine time and are dangerous in terms of forest fires

Fire conditions vary greatly depending on the aspect. In general, the south and southwest sides have good conditions for fire initiation and spread. These areas receive more sunlight. Increases the temperature of air and combustible material. (Figure 11).

7.35 percent of the area corresponds to critical risk, 16.04 percent to high risk, 16.03 percent to moderate risk, 12.69 percent to low risk, and 47.89 percent to no risk classification.

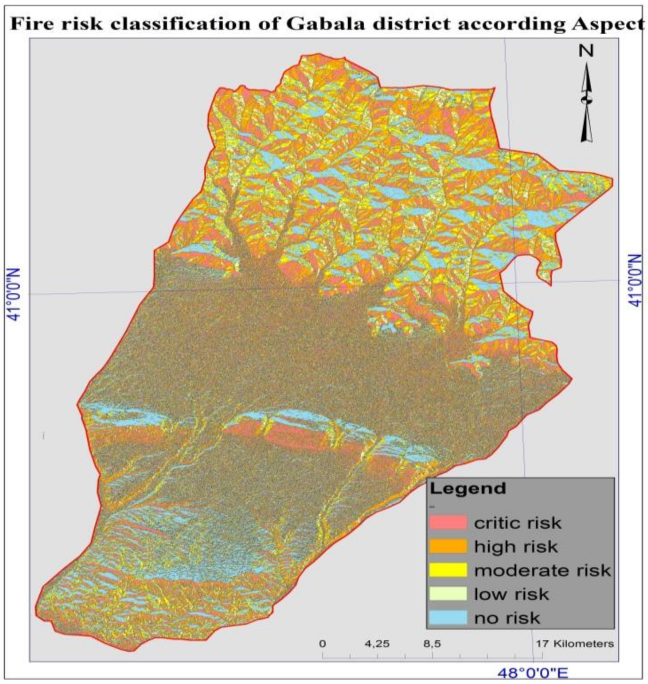


Figure 11. Fire risk classification according aspect

Elevation data is closely related to the distribution of vegetation. Vegetation in the study area is distributed along the vertical zonation of the mountainous area. Bushy and sparse meadows are spread in the central part, and semi-desert plants with wormwood and sorrel in the south, and arid type forests in the steppe plateau area. At altitudes of 600-2000 m, there are oak, beech and walnut forests. Subalpine (1700-2600 m) and alpine meadows (2500-3100 m) are common in the high mountain zone. At 3100-3500 m above sea level, subnival plants of the tundra type are found. Above 3500 m, the vegetation-free nival zone begins. Taking these into account, Elevatian classification was made again. Areas with an altitude of 500-2000 m are classified as critical risk zone, while areas higher than 3000 m are included in no-risk and low-risk categories (Figure 12).

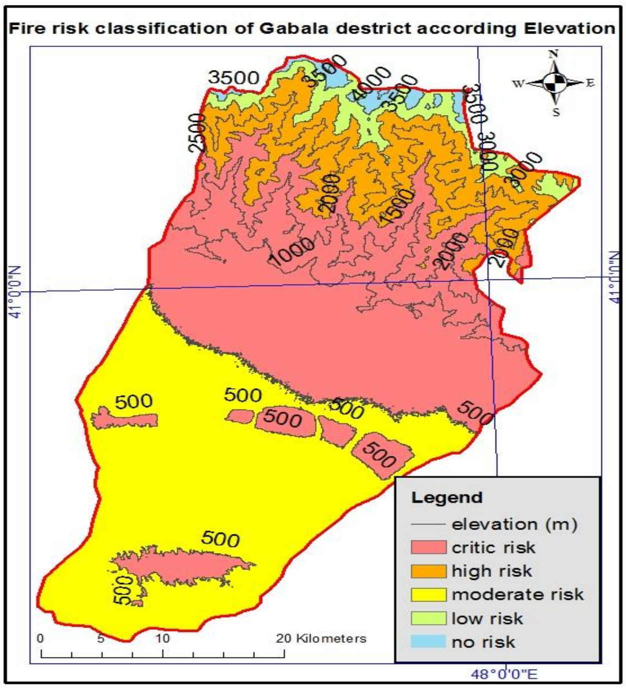


Figure 12. Fire risk classification acording elevation

5. Conclusion

Burned area data was used to verify the obtained data. The data is taken from the FIRMS database with 1000 m resolution from MODIS/MOD 14 sensors from the earth.data.nasa.gov application. Vectorized and area calculated using ArcGis 10.8 software. Data covers 2021 and 2022. The burnt forest area is 1826.3 ha, which is 5.4% of the forest area of Gabala district. 100 percent of the burned area corresponds to the high and critical risk classification zone. 2021 and 2022 data from MODIS (Aqua and Terra) sensors provided by NASA FIRMS are taken. In Gabala district, 11 fire incidents occurred in 2021 and 108 in 2022. 90% of recorded fire events correspond to the high and critical risk classification area, 8.4% to the moderate risk zone, and 1.6% to the low risk zone.

It is extremely important to be able to predict the potential fire risk and fire hazard of a region in forest fire fighting studies. In this way, potential areas with high fire risk and danger will be given priority in pre-fire planning, and protective and preventive measures will be handled more comprehensively in these areas. In this context, making the area safer in terms of forest fires by reducing the risk and danger of fire will be possible. Similarly, in order to effectively fight possible fires, these areas where the fire risk and danger are high should be given priority in the deployment, management and administration of resources and teams.

Author Contributions

The article was carried out by a single author.

Statement of Conflicts of Interest

There is no conflict of interest.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

References

Atun, R., Kalkan, K., & Gürsoy, Ö. (2020). Determining the forest fire risk with Sentinel-2 Images. Turkish Journal of Geosciences, 1(1), 22–26.

Bar, S., Parida, B. R., Pandey A.C. (2020). Landsat-8 and Sentinel-2 based forest fire burn area mapping using machine learning algorithms on GEE cloud platform over Uttarakhand, Western Himalaya. *Remote Sensing Applications: Society and Environment,* 18, 100324. https://doi.org/10.1016/j.rsase.2020.100324

Başaran M. E., Sarıbaşak H., & Cengiz Y. (2004). Yangın söndürme temel esaslarının belirlenmesi (Manavgat Örneği). *Batı Akdeniz Ormancılık Araştırma Müdürlüğü Teknik Bülten,* (18), 1-96.

Başkent E. Z. (2018). A review of the development of the multiple use forest management planning concept, *International Forestry Review,* 20(3), 296-313. https://doi.org/10.1505/146554818824063023

Betanzos, A. A., Romero, O. F., Berdinas, B. G., Pereria, E. H., Andarade, M. I. P., Jimenez, E., & Soto, J. L. L., Carballas, T. (2003). An intelligent system for forest fire risk prediction and fire fighting management in Galicia. *Expert Systems with Applications,* 25(4), 545-554. https://doi.org/10.1016/S0957-4174(03)00095-2

Castro, R., & Chuvieco, E. (1998). Modelling forest fire danger from GIS, *Geocorta International*, 13(1) 15-24. https://doi.org/10.1080/10106049809354624

Chuvieco, E., & Salas, F.J. 1996, Mapping the spatial distribution of forest fire danger using GIS. *International Journal of Geographical Information Systems,*10, 333-345. https://doi.org/10.1080/02693799608902082

Dong, X., Shao, G., Limin, D., Zhanging, H., Lei, T., & Hui, W. (2006). Mapping forest fire risk zones with spatial data and principal component analysis. *Science in China: Series E Technological Sciences,* 49(Supp. I), 140-149. https://doi.org/10.1007/s11434-006-8115-1

Goldammer, J. G., & Mutch, R. W. (2001). *Global forest fire assessment FAO forest resources assessment programme, working paper* 55. Retrieved July 13, 2023, from https://www.fao.org/3/AD653E/ad653e00.htm

Jaiswal, R., Mukherjee, S., Raju, K., & Saxena, R. (2002) Forest fire risk zone mapping from satellite imagery and GIS. *International Journal of Applied Earth Observation and Geoinformation*, 4(1), 1-10. https://doi.org/10.1016/S0303-2434(02)00006-5

Kuter, N., Yenilmez, F., & Kuter, S. (2011). Forest fire risk mapping by kernel density estimation. *Croation Journal of Forest Engineering*, 32(2), 599-610.

Məmmədov, Q., & Xəlilov M. (2022). *Azərbaycan meşələri.*

Müseyibov, M. (1998). Azərbaycanın fiziki coğrafiyası. *Maarif Yayınları*, 127-131.

Roy, P. S. (2003). Forest fire and degradation assessment using satellite remote sensing and geographic ınformation system. *Satellite Remote Sensing and GIS Applications in Agricultural Meteorology* pp. 361-400.

Versini, P., Velasco, M., Cabello, A., & Sempere-Torres, D. (2013). Hydrological ımpactof forest firesand climate change in Mediterranean Basin. *Natural Hazards*, 66 (2), 609-628. https://doi.org/10.1007/s11069-012-0503-z