Fire risk assessment for eight Lebanese villages and their surrounding

(Brief assessment report)

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In consultation with:

George Mitri, Ph.D.

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I. Introduction

This work was done under the Livelihoods in Forestry (LiF) project funded by the United States Agency for International Development (USAID) and implemented by the Lebanon Reforestation Initiative (LRI). It aims at providing a spatial assessment of wildfire risk in several Lebanese villages and their surroundings for improved fire risk management at the local level. The specific objectives are:

- Conduct field assessment for data collection;
- Generate a fire risk map (in function of hazard and vulnerability) using very high spatial resolution satellite imagery and field data; and
- Develop a preliminary list of recommendations in line with the best practice guidelines of Firewise and based on expert knowledge and the landscape specific characteristics.

The following is a list of villages where this study was conducted:

- Ajaltoun (Kesrouan)
- Bentael (Jbeil)
- Bkessine (Jezzine)
- Deir El Ahmar (Baalbek)
- Hamat/Wajh El Hajar (Batroun)
- Biosphere reserve (BR) of Jabal Moussa (JM) (Kesrouan/Jbeil)
- Menjez (Akkar)
- Qadisha Valley (QV)

II. Methodological Approach

An overall wildfire risk assessment was prepared for the forest of all the participating villages and their surrounding areas. Fire hazard and vulnerability were considered in these assessments upon data availability and the general characteristics of the site (IOE-UOB/LRI, 2014). Fire risk was assessed as a product of fire hazard and fire vulnerability (Risk = hazard x vulnerability).

Fire hazard assessment involved the use of data mainly related to the density of forest fuel. Fire vulnerability assessment comprised a number of environmental and socio-economic sensitivity factors (e.g. protected areas, managed forest areas, presence of homes, infrastructure, among others).

First, a field survey was conducted to assess the different characteristics of the landcover/land use of the study area. Second, field data in combination with the Worldview satellite imagery were employed in the analysis.

Consequently, three maps were produced, namely a fire hazard map (i.e., low hazard, moderate hazard, and high hazard), a fire vulnerability map (i.e., low vulnerability, moderate vulnerability, and high vulnerability), and a fire risk map (i.e., low risk, moderate risk, high risk, and very high risk).

Evaluating fire risk in the area involved the use of a cross mapping between hazard and vulnerability (as shown in **Table 1**). It is to be noted that the different classes of fire risk are relative to each study areas and cannot be used for comparison with fire risk maps of different study areas.

Table 1. Fire risk scoring matrix

Hazard \ Vulnerability	Low	Moderate	High
Low	**Low**	**Moderate**	**Moderate**
Moderate	**Moderate**	**Moderate**	**High**
High	**Moderate**	**High**	**High**

III. Study area and dataset description

Ajaltoun:

The study area is the village of Ajaltoun (geographic coordinates 33°58′4″N 35°41′6″E) and its surrounding (i.e., the villages of Ballouneh, Shaileh, Rayfoun, Mrah el Mir, and Daraya), located in Caza of Kesrouan in Lebanon (Error! Reference source not found.). The average elevation of the study area is 850 meters above sea level. The estimated population of of Ajaltoun is 3,750 residents.

Figure 1. Location of Ajaltoun

A field visit was conducted to the study area to describe the general physical characteristics of the site landscape (Error! Reference source not found.). The data of interest was mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio-economic sensitivity factors, fire hazard and vulnerability, and infrastructures. In addition, a recent very high spatial resolution satellite imagery (Worldview) was acquired for the study area.

The image helped in delineating the extent of vegetated areas, assessing vegetation density, and mapping houses and infrastructure.

Figure 2. Overview of the forest area on the northern side of the study area

The natural landscape of Ajaltoun comprises relatively large areas of oak trees and urban green areas. The main forested areas are located on both the northern side and the southern side of the village (Error! Reference source not found. and **Table 2**). Settlements are scattered almost all over the landscape increasing the extent of Wildland-Urban Interface. Few waste disposal sites are present near vegetated areas mainly in the southern part of the village. These waste disposal sites are usually set on fire very frequently.

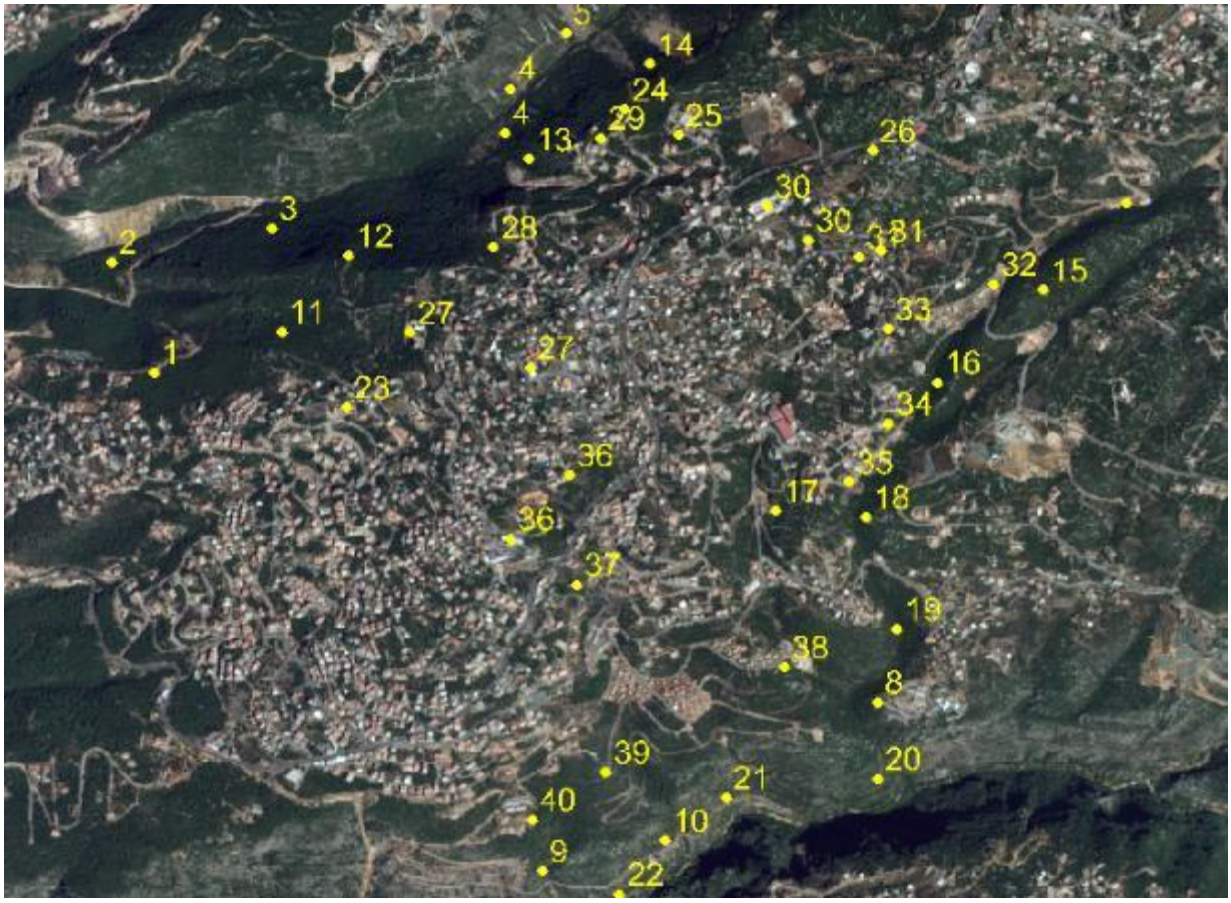


Figure 3. Expansion of the natural landscape in Ajaltoun and its surrounding (a description of coded numbers is presented below).

Table 2. Description of identified points of interest in Ajaltoun

ID	Description	ID	Description
1	Random waste dump	23	Water reservoir
2	Random waste dump	24	Deep Well
3	Random waste dump	25	Water reservoir
4	Random waste dump	26	Country Club: Sun City Pool
4	Random waste dump	27	School
5	Random waste dump	27	Church
6	Random waste dump	28	Houses
7	Random waste dump	29	Houses
8	Industrial Plant for cartridge	30	Demographic Vulnerabilities
9	Random waste dump	30	School

10	Random waste dump	31	Seasonal Felling and intended fires
11	Green areas/forest	31	Various Demographic Vulnerabilities
12	Green areas/forest	32	Various Demographic Vulnerabilities
13	Green areas/forest	33	Various Demographic Vulnerabilities
14	Green areas/forest	34	Various Demographic Vulnerabilities
15	Green areas/forest	35	Various Demographic Vulnerabilities
16	Green areas/forest	36	Various Demographic Vulnerabilities
17	Green areas/forest	36	School and Monastery
18	Green areas/forest	37	Various Demographic Vulnerabilities
19	Green areas/forest	38	Various Demographic Vulnerabilities
20	Green areas/forest	39	Construction area
21	Green areas/forest	40	Construction area
22	Green areas/forest	-	-

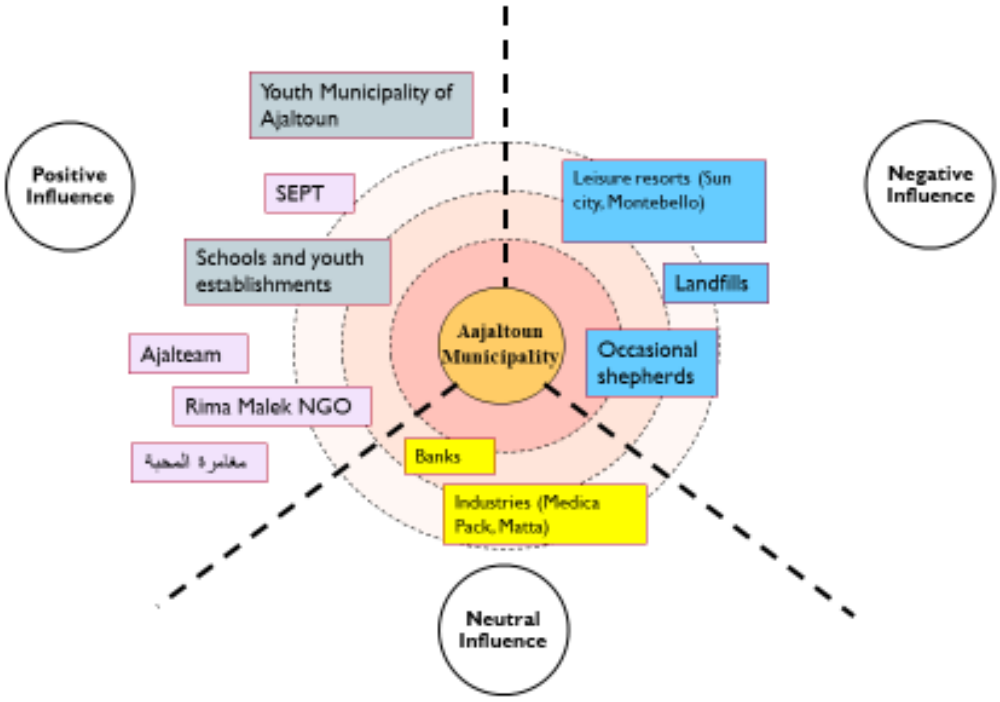


Figure 4. Stakeholder analysis in Ajaltoun

Bentael:

The study area is located in the village of Bentael which is situated at 250 m to 850 m above sea level (Error! Reference source not found.). The Reserve lies on the valley's foothills to the East of Byblos, has a total surface of 110 ha and is composed of dense woodland. The pine (*Pinus pinea*) is one of the most common trees in the Reserve. A variety of oak trees is interspersed among the Reserve's pine trees. The eastern part of the Reserve is composed of an open space of dense and low height oak trees.

Figure 5. The Reserve as seen from the eastern side (left) and from the southern side (right)

Field visits were conducted to the study area to describe the general physical characteristics of the site landscape. The data of interest were mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio economic sensitivity factors, fire hazard and vulnerability, and infrastructures. In addition, very high spatial resolution satellite imagery (Worldview and SPOT) were acquired for the study area. The images helped in delineating the extent of vegetated areas and in assessing vegetation density.

Between 1999 and 2014, fires occurred in the surroundings of the Reserve threatening the entire vegetation cover within the protected area. Most recently, a project to build a nearby road is expected to increase fire risk in the Reserve especially that it is located close to the bottom of the Reserve which is lying on a south-aspect slope (i.e., prevailing drought conditions).

The Bentael Nature Reserve has received in the past an initial support from FAO for forest protection from fires. This included the provision of necessary fire extinction equipment and infrastructure to help in controlling fires. The fire protection system was partially implemented through a relatively recent project in collaboration with the Agence Française de Développement (AFD) within the surrounding areas of the Reserve. Activities included 1) building a water tank of 140 m^3 and 2) water canalization linked to the existing pones and to the water reservoir.

Bkessine:

The study area is the village of Bkessine located at an average altitude of 800 meters above sea level south of Jezzine in South Lebanon. The surface of Bkessine village stretches for 507 ha. The pine forest (*Pinus pinea*) in Bkessine has an area of around 200 ha comprising different zones of dense vegetation cover (including trees, shrubs and grass). In some places across the study area, thick forests developed characteristics of multiple layered vegetation formations that support an increased fire spread.

Bkessine counted 625 residents (estimation). Parts of the Bkessine forest are managed for pine seed collection. Tree pruning and understory cleaning activities are practiced in some parts of the forest. The forest hosts a wide range of activities (e.g. ecotourism) including hiking, horsing and camping, among others. During the past decades, a number of fires occurred within the forest and in its surrounding. In 2014, a surface fire burned a relatively large extent of understory vegetation in the southern part of the forest (Error! Reference source not found.).

Figure 6. Surface fire in Bkessine (left) and forest ground cleared by fire (right)

Field visits were conducted to the study area to describe the general physical characteristics of the site landscape. The data of interest were mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio economic sensitivity factors, fire hazard and vulnerability, and infrastructures. In addition, a recent very high spatial resolution satellite imagery (Worldview) was acquired for the study area. The image helped in delineating the extent of vegetated areas and in assessing vegetation density.

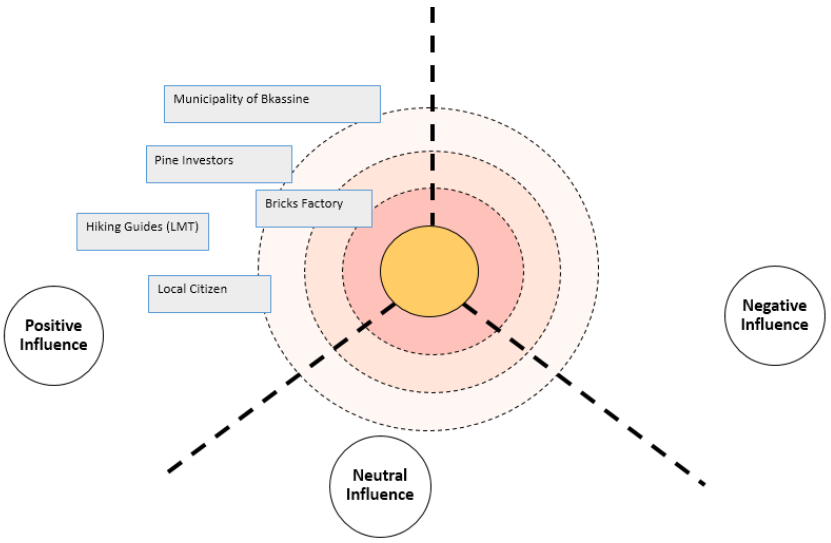


Figure 7. Stakeholder Analysis of Bkassine

Deir El Ahmar:

The study area is the village of Deir el Ahmar (DA) and its surrounding area. The village is located at 100 km from Beirut and its elevation varies between 1,050 m and 1,280 m above sea level (**Figure 8**). It extends on the eastern slopes of the western Lebanese mountain chain in North Bekaa. The climate in Deir El Ahmar is mild during spring and autumn, dry and hot during summer, and cold during winter.

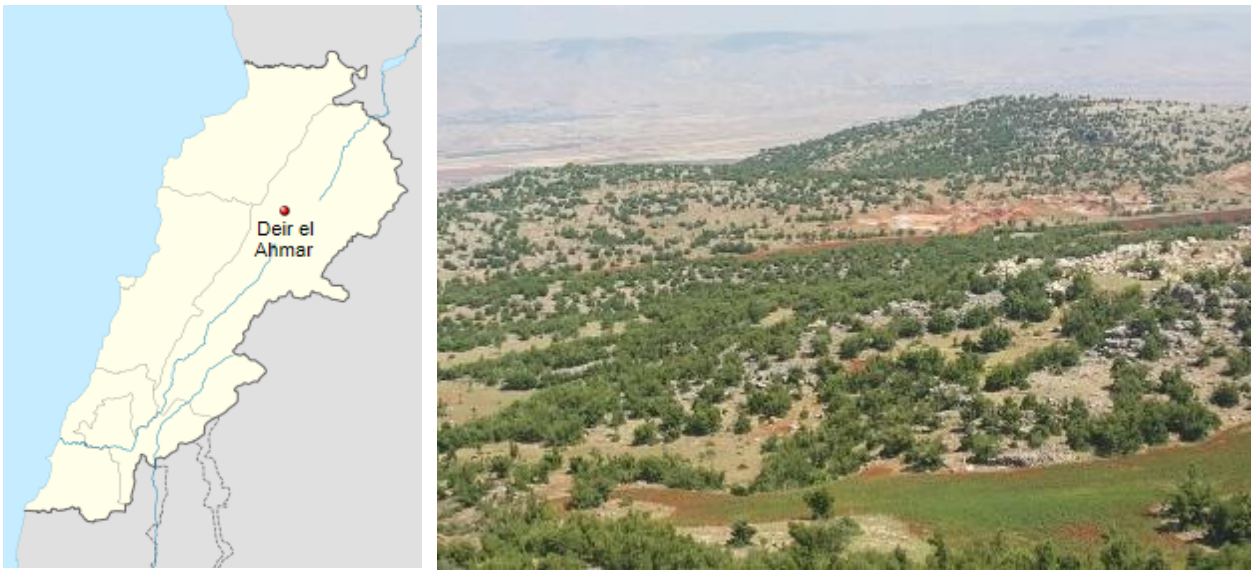


Figure 8. Location of DA (left) and part of the forest area (right)

A field visit was conducted to the study area on 19-5-2016 to describe the general physical characteristics of the site landscape. The data of interest were mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio-economic sensitivity factors, fire hazard and vulnerability, and infrastructures.

Sparse and medium oak forests are extensively distributed over the study area. Grazing (up to 2,000 heads) and charcoal production are widely practiced. The village also hosts several small-scale quarries – the rocks of Deir El-Ahmar are famous and well sought for their color (mildly red). The tourism sector has a good potential, based on cultural, religion and landscape. Yet, agriculture is the main source of income. In general, crops, fruit trees and agro-sylvo-pastoralism are the dominant agricultural practices in the area (**Figure 9**). Range lands offer important plant cover and biomass to sustain grazing activities throughout the year. The Ministry of Agriculture is present in the village through a forest nursery and a Forest Guards Center. Also, there is a center for the Civil Defense. The most recent fire in the area occurred in 2015. The fire started from a road passing through the affected vegetated area (**Figure 10**).

Figure 9. A mosaic of forested areas and agricultural lands

Figure 10. Vegetation affected by the most recent fire in 2015

In addition, a recent very high spatial resolution satellite imagery (Worldview) was acquired for the study area (**Figure 11**). The image helped in delineating the extent of vegetated areas, assessing vegetation density and mapping houses infrastructure (**Table 3**).

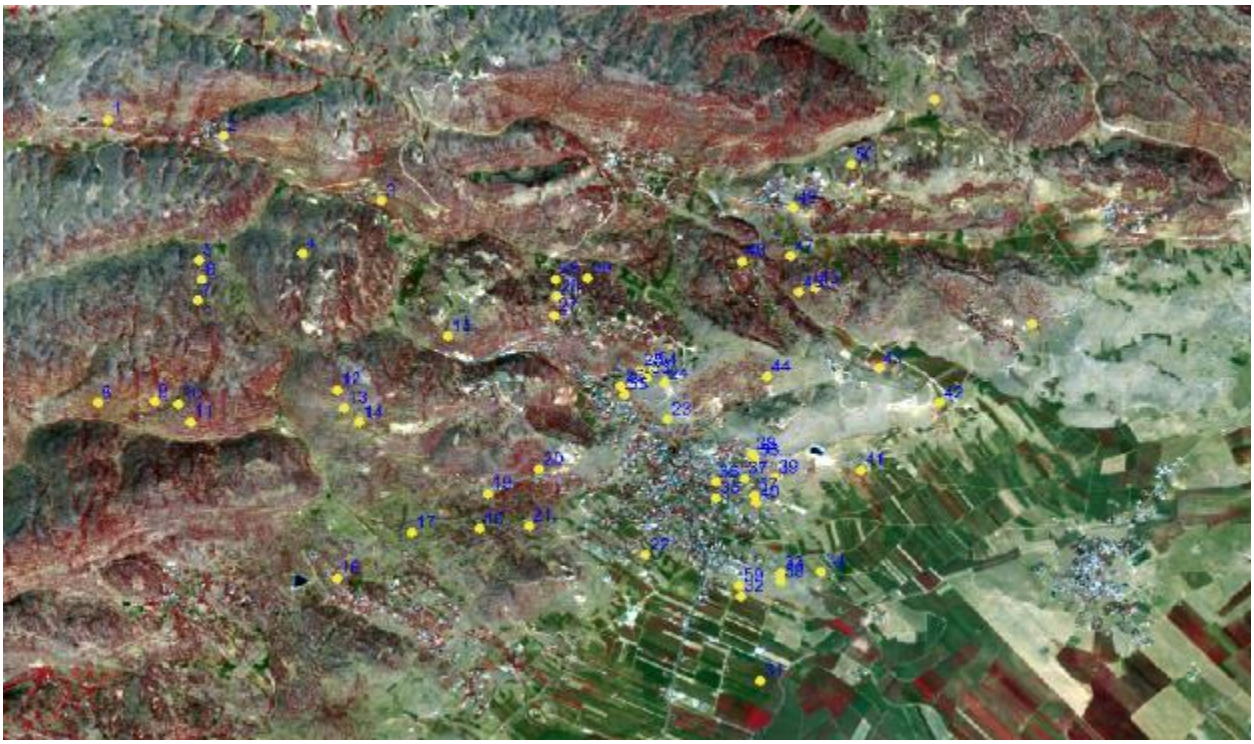


Figure 11. Expansion of the natural landscape of DA and its surrounding (a description of coded numbers is presented below).

Table 3. Description of identified points of interest in DA

ID	Description	ID	Description
1	3 hill lakes in Mchaytieh valley	31	St. Famille Abreen School
2	St. John church in Mchaytieh	32	Forest nursery of Ministry of Agriculture
3	St. Charbel church in Blayka	33	Public school
4	Hunting areas	34	Women Association of Deir el Ahmar
5	Fire wood and charcoal production	35	St. Joseph Church
6	Illegal Charcoal production	36	Hill lake of Btedii
7	Arson fire	37	Fireworks (festival site)
8	St. Gerjes church in Mrah El kloud	38	St. Nohra church
9	Scout activities in summer and fall season	39	Santa Maria tower
10	St. Peter and Paul in Ajwa	40	Archbishopric

11	Winter Habitat for local herds	41	Hill lake of north Kouroum in Deir el Ahmar
12	Fire wood and charcoal production	42	Winery
13	Illegal Charcoal production	43	Rosary Monastery
14	Arson fire	44	Winter Habitat for local herds
15	Road border	45	Picnic areas under the oak trees
16	Artesian wells	46	Picnic areas
17	Apia Road Romain road	47	Road border
18	Yammouneh irrigation canal	48	Hunting areas
19	Road border	49	Fireworks (festival site)
20	St. Elie church at Beit Kozah area	50	Hill lake of Bechwatt
21	Sahlatt Beit Kozah hill lake	51	Garbage disposal site
22	Cold storage	52	Winter Habitat for local herds
23	Fireworks (festival site)	53	Civil Defense center
24	Drinking water tank for Deir el Ahmar	54	Les sœurs de la croix
25	Forest Guards center of the Ministry of Agriculture	55	St. Mickael church in Bssayli
26	Medical center	56	Public School
27	Arson fire	57	Municipality building
28	Illegal Charcoal production	58	Police station
29	Fire wood and charcoal production	59	General security station
30	Hill lake of Qornet Beit Satiti	-	-

Figure 12. Stakeholder analysis in Deir El Ahmar

Hamat/Wajh El Hajar:

The study area comprises the villages of Hamat and Wajh el Hajar, located in the Mohafazat (i.e., governorate) of North Lebanon, at an elevation between sea level and 254 m above the sea level (**Figure 13**). The study area comprises one military airport. Also, it is home to historic shrines and monasteries including Our Lady of Nourieh, and Mar Semaan among others. The village of Hamat overlooks the Jawz River, El Mseilha archeological site, the Batroun/Mseilha dam, and the coastal town of Batroun.

Figure 13. Location of the study area (left) and part of the forested area (right)

Field information has been collected to describe the general physical characteristics of the site's landscape. The data of interest were mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio-economic sensitivity factors, fire hazard and vulnerability and infrastructures.

The study area is characterized by different types of landcover/land use namely a dense forest of oak trees, shrubland/grassland, and agricultural land. In general, many parts of the study area are characterized by a dense forest cover (mainly *Quercus calliprinos* species). Also, few areas are covered by dense pine forest (mainly *Pinus brutia and Cupressus sempervirens* species).

Settlements are mainly found in the center of the village Hamat and Wajh el Hajar. Most recent fire (**Figure 14** to **Figure 18**) occurred in October 2007, July 2012, July 2014 (starting the seaside of Hery), September 2014 (near the military airport), September 2016 (southern part opposite Batroun area), and July 2016 (near the highway creating transportation safety problems).

Figure 14. Fire of October 2007

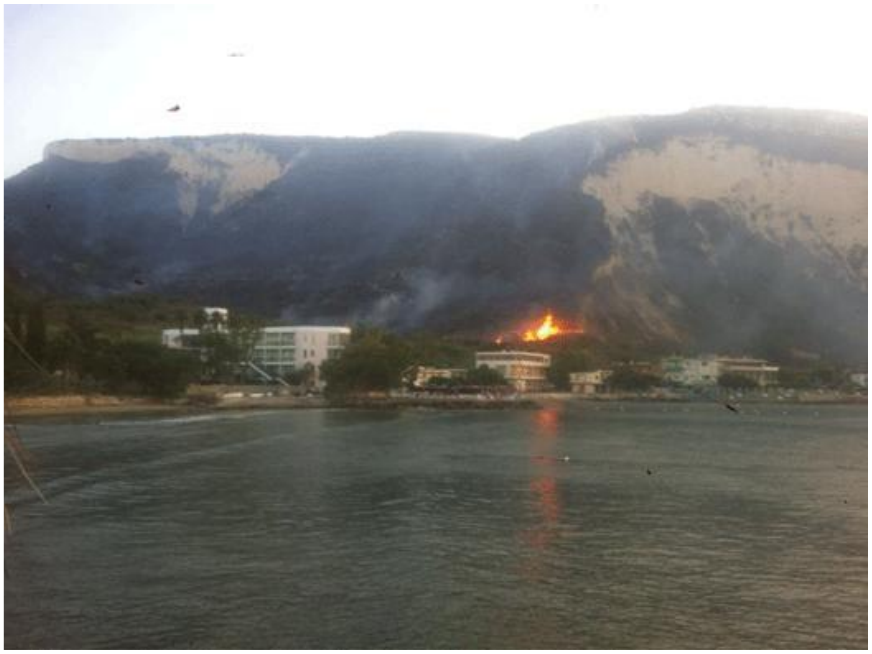


Figure 15. Fire of July 2014

Figure 16. Fire of September 2014

Figure 17. Fire of July 2016

Figure 18. Fire of September 2016

In addition, very high spatial resolution satellite imagery (Worldview) acquired on 30-9-2014 with a spatial resolution of 0.4 m was employed in this work. Points indicating features of vulnerability towards wildfires (**Table 4**) were displayed over the satellite image (**Figure 19**). In addition, the image helped in delineating the extent of vegetated areas, assessing vegetation density, and mapping houses and infrastructure. More specifically, the image showed clearly the scorched area of the July 2014 fire.

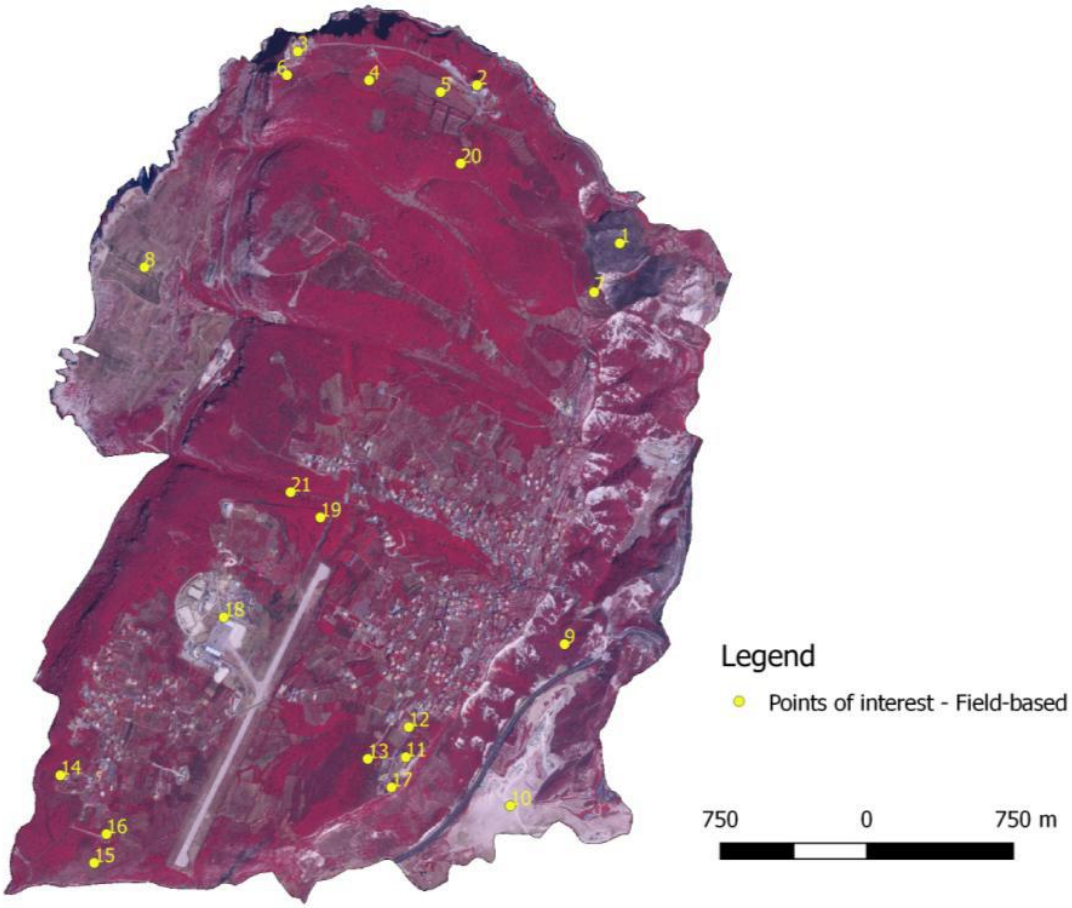


Figure 19. Points of interest in Hamat and Wajh el Hajar

Table 4. Description of identified points of interest in Hamat/Wajh El Hajar

ID	Description	ID	Description
1	Burned area of July 2014	12	Municipal ground for activities
2	Shrine of Sayyidet el Nourieh	13	Antenna
3	Monastery of St. Semaan	14	Landfill in Wajh el Hajar
4	Palm tree cultivation	15	Burned area
5	Cactus cultivation	16	Church
6	Burned land	17	Mar Elias church
7	Communication infrastructure	18	Military airport and infrastructure
8	Ground of military trainings	19	Dense vegetation cover (oak)
9	*Pinus brutia* vegetation cover	20	Fenced and managed forest
10	Dam construction site	21	Picnic area on road sides
11	Municipal club	-	-

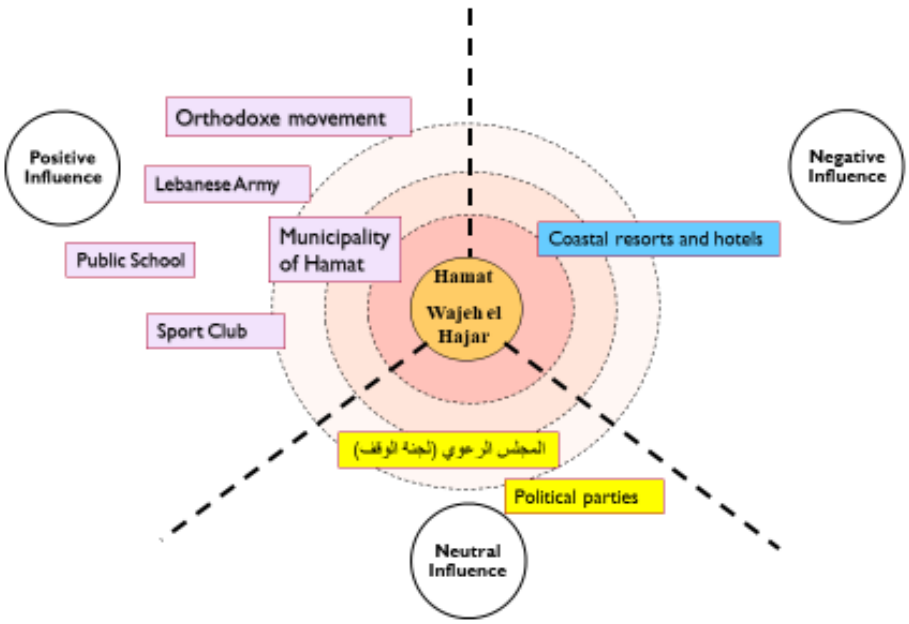


Figure 20. Stakeholder analysis in Hamat/Wajeh El Hajar

Jabal Moussa:

The study area is the BR of JM (N 34º 03’ 43.93”, E 35º 46’ 09.84”), designated and its surrounding (i.e., the villages of Yahchouch, Ghbeleh, Qehmez, Nahr el Dahab, Ain el Delbeh, Al Iibre and Chouwan) by UNESCO in 2009 as the third BR in Lebanon. It is located in Caza of Kesrouan in Lebanon (**Figure 21**). The BR is located 50 km away from the capital Beirut.

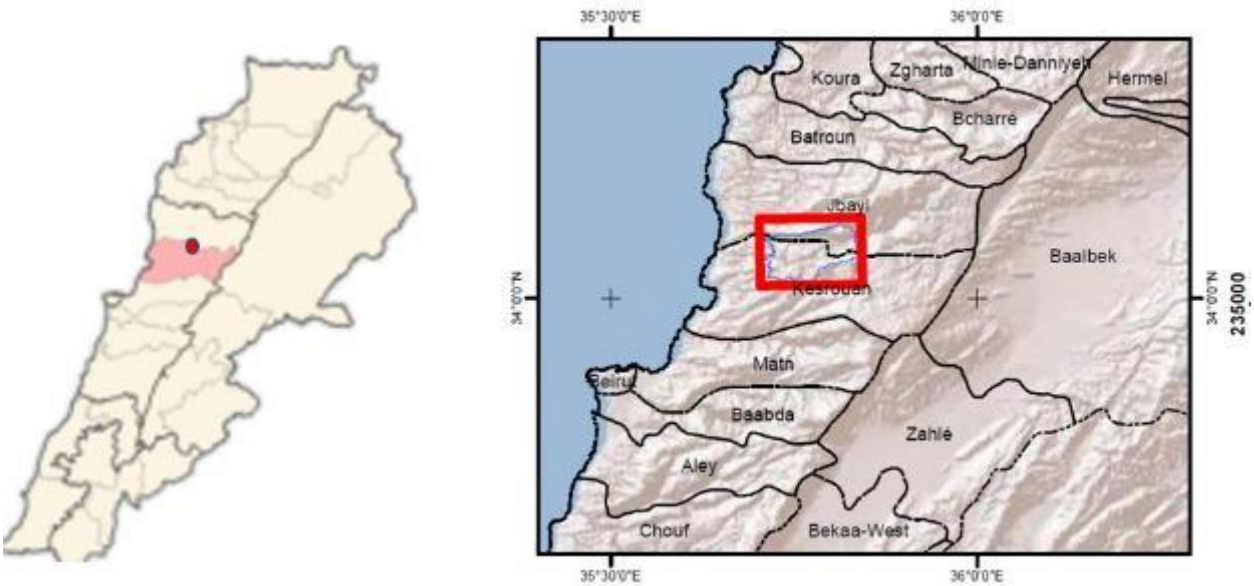


Figure 21. Location of Jabal Moussa BR Kesrouan-Jbeil (left) and its delineation (right)

The BR covers an area of 6,500 ha at an altitude ranging between 350m and 1,700m. It extends 500m beyond the rivers of Nahr Ibrahim to the north and Nahr el Dahab to the south. The BR is divided into a core area, a buffer zone where more ecotourism activities take place, and a transition zone (covering around half of the BR's area) that involves human activities and use of land (**Figure 22**). The main activities in the transitional zone include forest management, charcoal production, traditional agricultural activities, fruit trees plantation and grazing, among others.

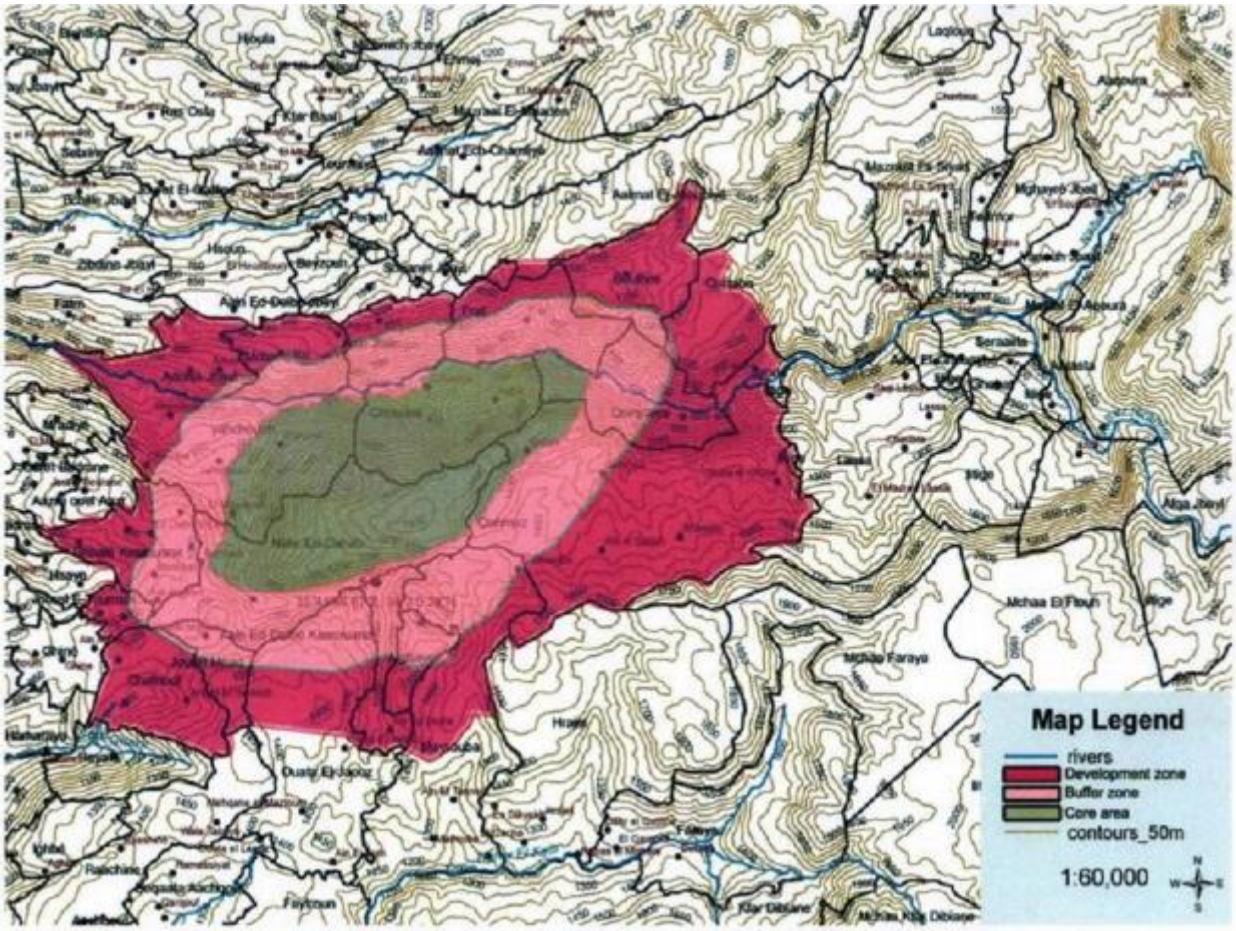


Figure 22. Zonation of the BR (source: Association for the Protection of Jabal Moussa)

The phyto-ecological map of JM (**Figure 23**) showed the presence of different types of vegetation formation. These include, among others, dense and open forests of *Quercus calliprinos, Quercus cerris, Quercus infectoria, Pinus brutia,* and *Styrax officinalis,* dense forest of *Ostrya carpinifolia*, riparian vegetation including *Platanus orientalis,* and grassland.

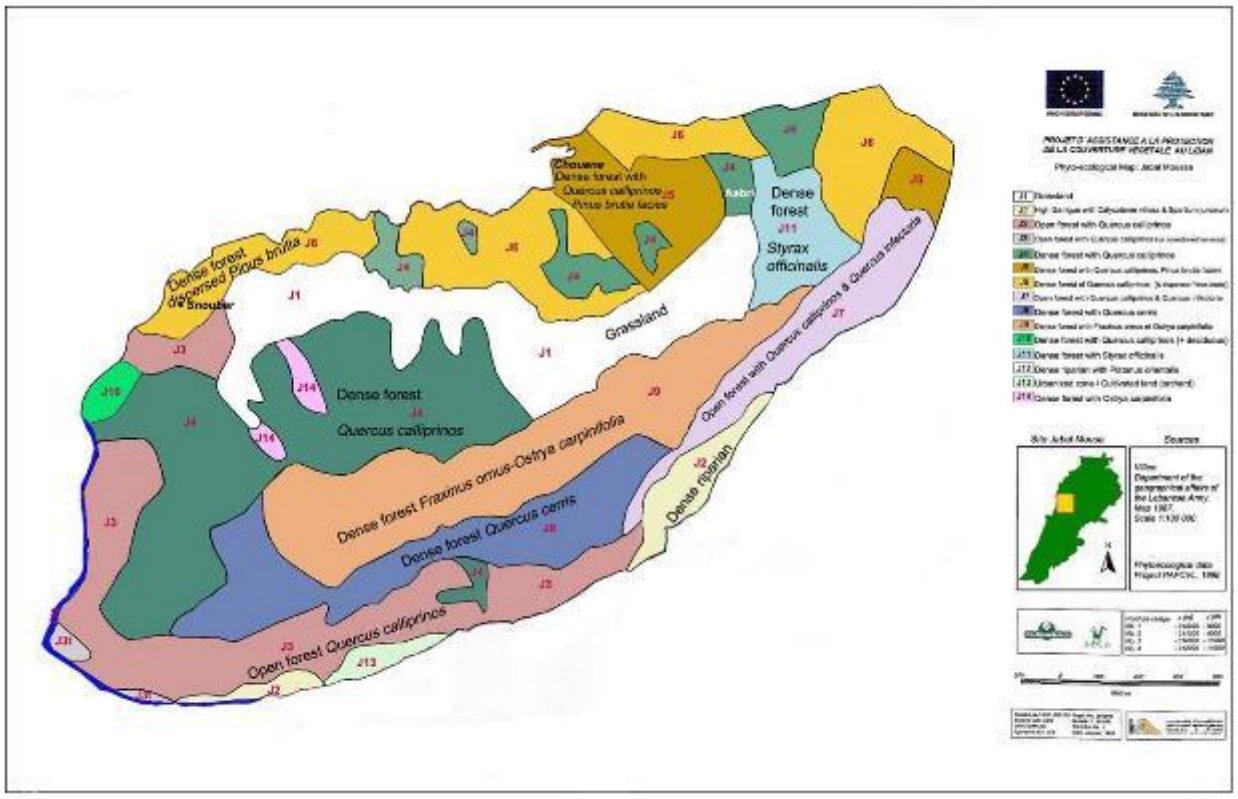


Figure 23. Phyto-ecological map of Jabal Moussa (source: Khatib and Alami)

A field visit was conducted to the study area on 14-5-2016 to describe the general physical characteristics of the site landscape (**Figure 24**). The data of interest were mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio-economic sensitivity factors, fire hazard and vulnerability, and infrastructures. In addition, a recent very high spatial resolution satellite imagery (Worldview) was acquired for the study area. The image helped in delineating the extent of vegetated areas, assessing vegetation density and mapping houses infrastructure (**Table 5**).

Figure 24. Expansion of the natural landscape in JM (polygon highlighted in green) and its surrounding (a description of coded numbers is presented below).

Table 5. Description of identified points of interest in JM

Code Number	**Description**	**Code Number**	**Description**
1	JM camping site	15	Charcoal production
2	Restaurants and picnic areas	16	Charcoal production
3	Camping area 2	17	Charcoal production
4	Camping area 3	18	Charcoal production
5	Occasional campfire	19	Charcoal production
6	Occasional camping	20	Charcoal production
7	Waste disposal area	21	Mar Jerges Monastery
8	Waste disposal site 2	22	Old Houses
9	Waste disposal site 3	23	Yahchouch Cross
10	Waste disposal site 4	24	Chouwan Kiosk & Entrance

11	Charcoal production	25	Church – Saint Therese
12	Charcoal production	26	Yahchouch Public School
13	Charcoal production	27	Church – Mar Takla
14	Charcoal production	--	

The Natural landscape of the BR is characterized by a mosaic of land covered by coniferous forests with scattered broadleaf tree species, diverse mixed oak forest, broadleaf forest, mixed forests, and riparian vegetation (**Figure 25**). Also, there are many areas covered by abandoned agricultural land and settlement.

Figure 25. Overview of the forest area from the area of Chouan

The area in Chouan is frequently visited by many tourists and visitors throughout the year and especially in the spring and summer seasons. Infrastructures for visitors have already been established in the area (**Figure 26**).

Figure 26. Infrastructure within forested areas for visitors in Chouan

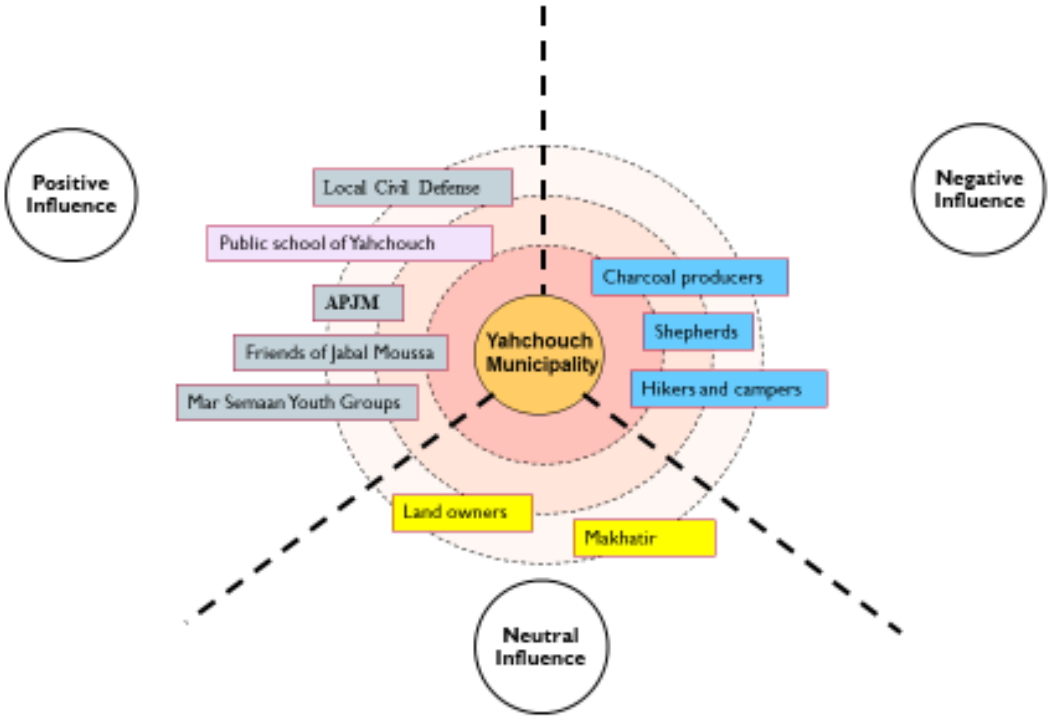


Figure 27. Stakeholder analysis in Jabal Moussa

Menjez:

The study area is the village of Menjez located in the north of Lebanon in the Mohafazat (i.e., governorate) of Akkar, close to the Syrian border, at an elevation between 290 m and 350 m above the sea level (**Figure 28**).

Menjez has an approximate population of around 550 permanent inhabitants. The total number of inhabitants may significantly increase during the summer season.

Figure 28. Location of Menjez (left) and part of the forested area (right)

Field information has been collected to describe the general physical characteristics of the site's landscape. The data of interest were mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio-economic sensitivity factors, fire hazard and vulnerability, and infrastructures.

The study area is characterized by different types of landcover/land use namely a dense mixed forest of laurel and oak trees, grassland, and agricultural land. Settlements are mainly found in the center of the village. A total of 10 ha of land were afforested using native tree seedlings (e.g. *Laurus nobilis, Pinus pinea, and Ceratonia siliqua*) between the years 2014 and 2016 within the framework of a project funded by the EU, managed by the Ministry of Agriculture and implemented by the University of Balamand. Also, there is a center for the Civil Defense in the village. The most recent fires in the area occurred in the summer of 2016 affected mainly grassland and recently reforested areas.

In addition, a relatively recent very high spatial resolution satellite imagery (SPOT 2.5 m color) was acquired for the study area. Points indicating features of vulnerability towards wildfires were displayed over the SPOT image (**Figure 29**, **Table 6**). In addition, the image helped in delineating the extent of vegetated areas, assessing vegetation density, and mapping houses and infrastructure.

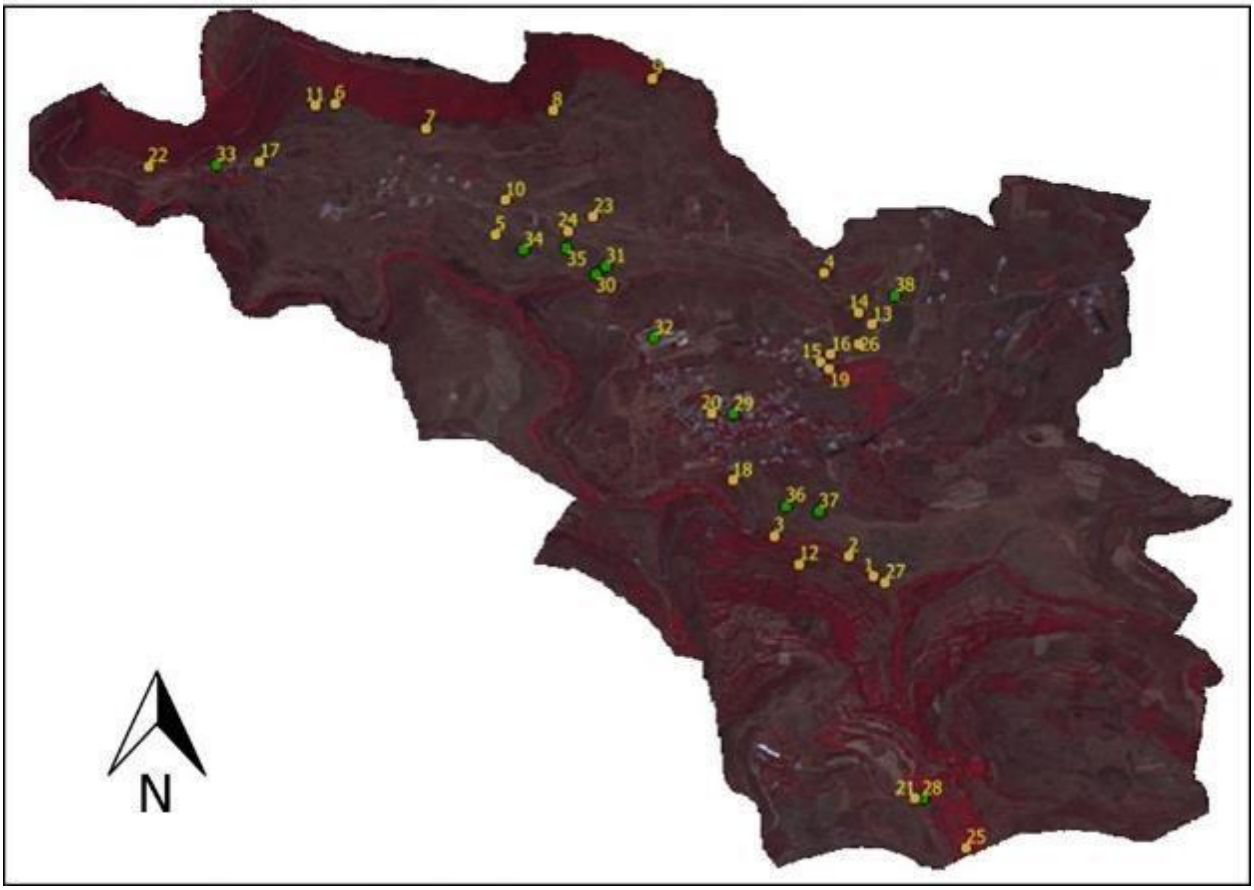


Figure 29. Points of interest in Menjez

Table 6. Description of identified points of interest in Menjez

ID	Description	ID	Description
1	Usual picnic area	20	Church
2	Usual picnic zone	21	Greco Roman Nemesis Temple
3	Usual picnic zone	22	Felicium Crusaders' castle
4	Usual picnic zone	23	Prehistoric tombs
5	Usual picnic area	24	Prehistoric tombs
6	Usual picnic area	25	Spring Jaalouk
7	Usual picnic area	26	Future artificial lake to be finished this year
8	Usual picnic area	27	Water reload for Civil Defense
9	Usual picnic area	28	Archeological site

10	Wood factory	29	Settlement
11	Charcoal production	30	Burned
12	Charcoal production	31	Burned
13	Fireworks area (only few times a year)	32	School
14	Cemetery	33	Monastery
15	Municipality	34	Reforestation site
16	Civil Defense	35	Reforestation site
17	Military outpost	36	Reforestation site
18	Military outpost	37	Reforestation site
19	Cooperative	38	Reforestation site

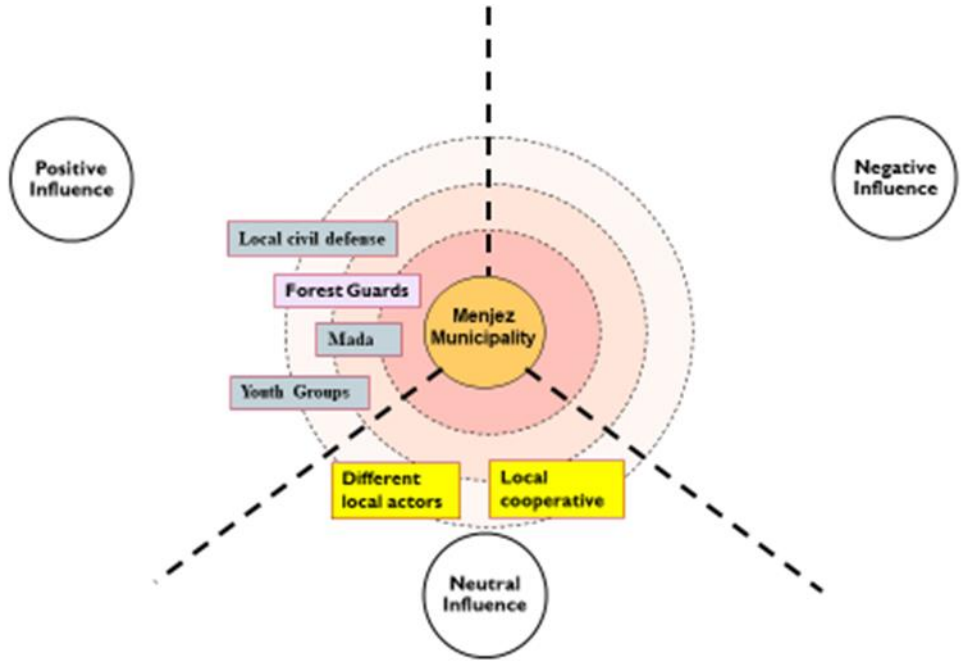


Figure 30. Stakeholder analysis in Menjez

Qadisha:

The study area is Qadisha Valley (N34 14 35.988 E36 2 56.004), designated as UNESCO World Heritage Site in 1998, and its surrounding (**Figure 31**). QV extends within Bsharreh and Zgharta districts in North Lebanon. It is characterized by steep cliffs on its both sides. QV is protected by Ministerial Orders 13/1995 and 60/1997 enacted by the Ministry of Culture, by Order 151/95 enacted by the Ministry of the Environment, and by the Antiquities Law 166/1933. The creation of a Regional Park and the development of a detailed management plan to ensure the integrity and authenticity of the property were previously recommended by the World Heritage Committee.

Figure 31. Location of QV (left) and the upper part of QV (right)

QV is surrounded by a number of villages including Bsharreh, Hasroun, Hadshit, Blawza, Sereel, and Mazraaet el Nahr (**Figure 32**).

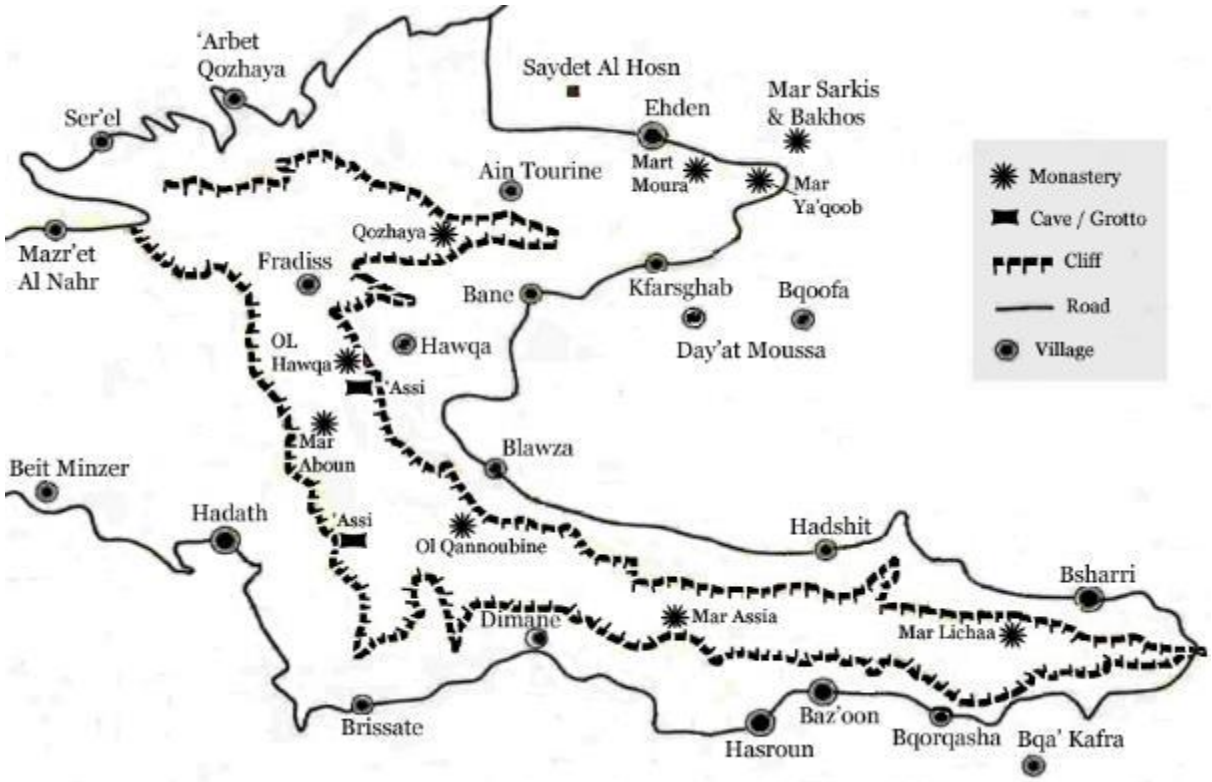


Figure 32. Villages surrounding QV

A field visit was conducted to the study area on 7-5-2016 to describe the general biophysical characteristics of the landscape. The data of interest were mainly inherent to vegetation (biomass) as fuel, environmental conditions, socio-economic sensitivity factors, fire hazard and vulnerability and infrastructures.

The study area is characterized by plant formations of different vegetation stages. Main vegetation species include *Pinus brutia, Quercus calliprinos, Platanus orientalis, Malus trilobata, Laurus nobilis, and Cupressus sempervirens* among others (GFMC, 2010). The vegetation composition indicates an accumulation of vegetation fuel (both live and dead material) that increases significantly fire hazard especially in the Wildland-Urban Interface as well as in the Wildland-Agricultural Interface (**Figure 33**). Progressive invasion of shrub and grasses on abandoned agricultural lands and other open spaces has contributed to major causes of landscape degradation. Also, the pressure exerted by the increasing number of visitors brings additional risk of fire occurrence.

Figure 33. Recent fires in the Wildland-Urban Interface of QV (upper) and near agricultural land (lower)

The presence of high voltage power lines and the installation of new towers for these power lines (**Figure 34**) across the valley are also expected to increase the risk of fire occurrence.

Figure 34. Towers of high voltage power lines in QV

A recent very high spatial resolution satellite imagery (Worldview) was acquired for the study area. The image helped in delineating the extent of vegetated areas, assessing vegetation density and mapping houses infrastructure (**Figure 35** and **Table 7**).

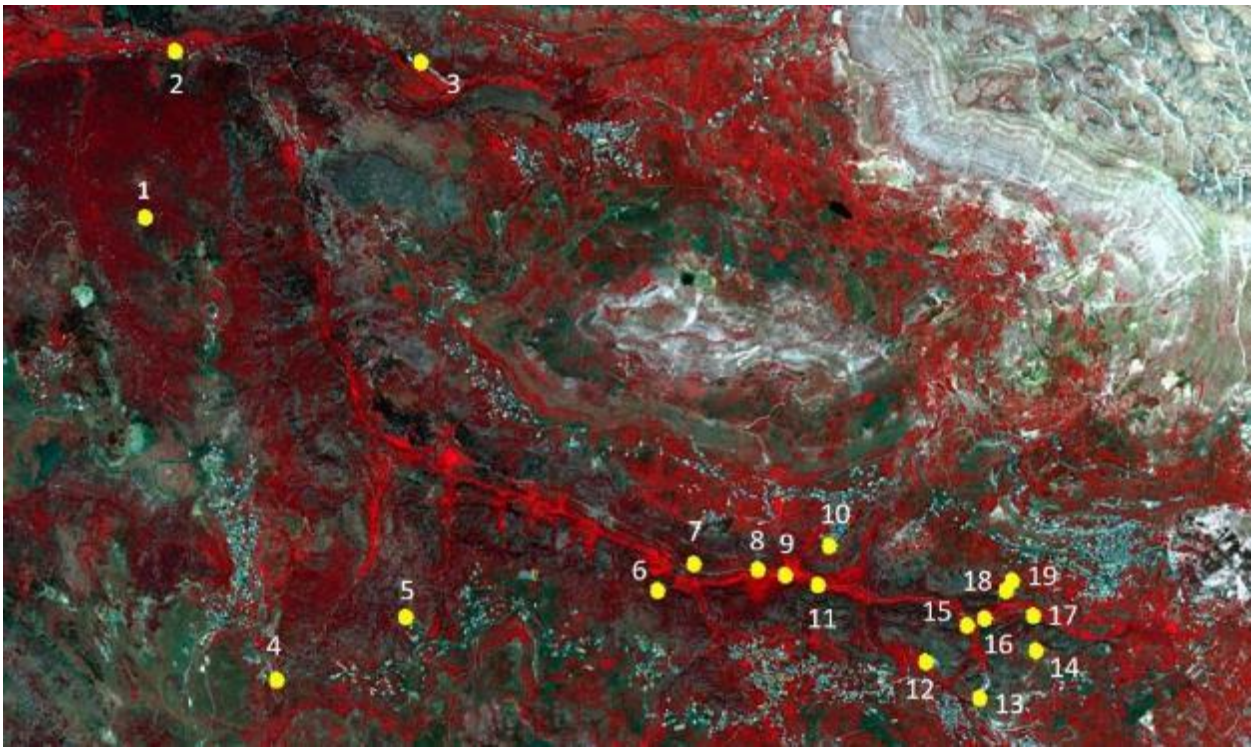


Figure 35. Expansion of the natural landscape of QV and its surrounding (a description of coded numbers is presented below).

Table 7. Description of identified points of interest in QV

Code number	**Description**	**Code number**	**Description**
1	Charcoal production/Tourza/Qnaiouer/Beit Menzer	11	Picnic area
2	Sereel power plant	12	Cemetery Berkash
3	Infrastructure	13	Restaurant
4	Public garden (eastern entrance)	14	Infrastructure
5	Charcoal production	15	Qadisha power plant
6	Old thick forest	16	Guest house
7	Orchard and agricultural lands	17	Picnic area
8	Picnic area	18	Old Monastery
9	Picnic area	19	Mar Jerges public gardens
10	Cemetery Hadchit	--	

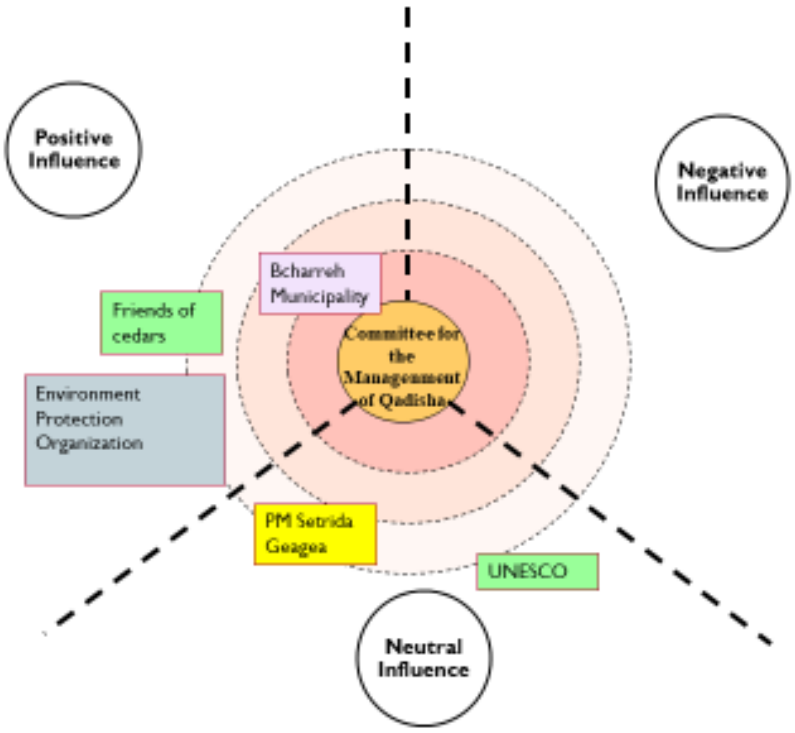


Figure 36. Stakeholder analysis in Qadisha Valley

IV. Results and Discussion

Ajaltoun:

Three maps were produced, namely, fire hazard, vulnerability and risk (**Figure 37**, **Figure 38**, and **Figure 39**). Percentages of spatial coverage of classified classes are provided in **Figure 40**. The main observations from the classification results were as follows:

- Around 36% of the study area was classified as high hazard, while the remaining parts were classified as moderate to low hazard. It is to be noted that the class high hazard was mainly attributed to areas covered by dense forest cover mainly composed of oak and other shrub species.
- Around 50% of the total area of interest was classified as moderate to high vulnerability. High vulnerability areas represented mainly houses and infrastructures located close to dense forest fuel. Simultaneously, moderate vulnerability represented areas covered by relatively tall oak trees.
- Around 36% of the area was classified as high risk, and 60% as moderate risk. High risk areas represented mainly dense oak forest on slopes, in addition to combustible fuel in the Wildland-urban interface. Other exposed forested areas were classified as moderate risk.

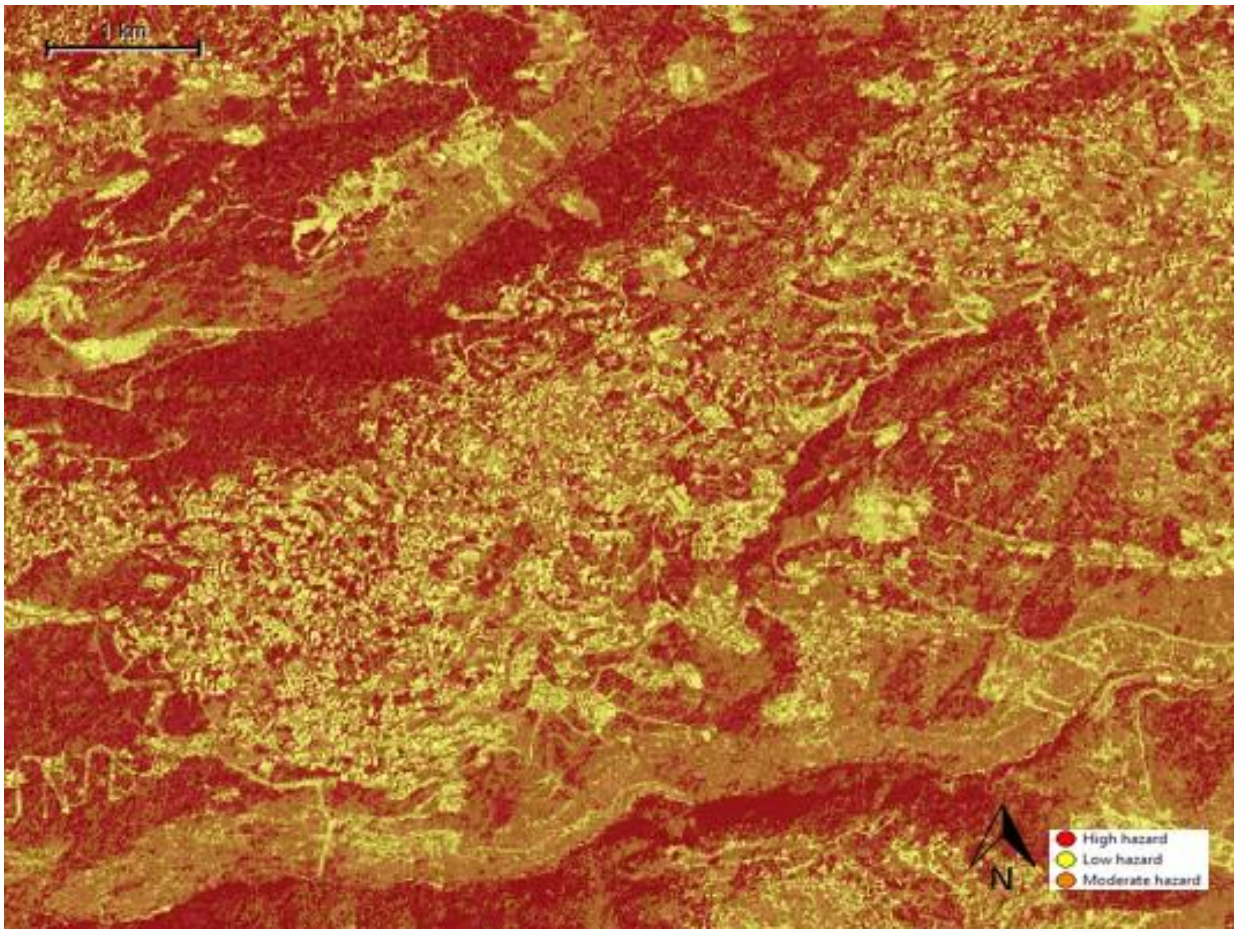


Figure 37. Fire hazard map of Ajaltoun and its surrounding

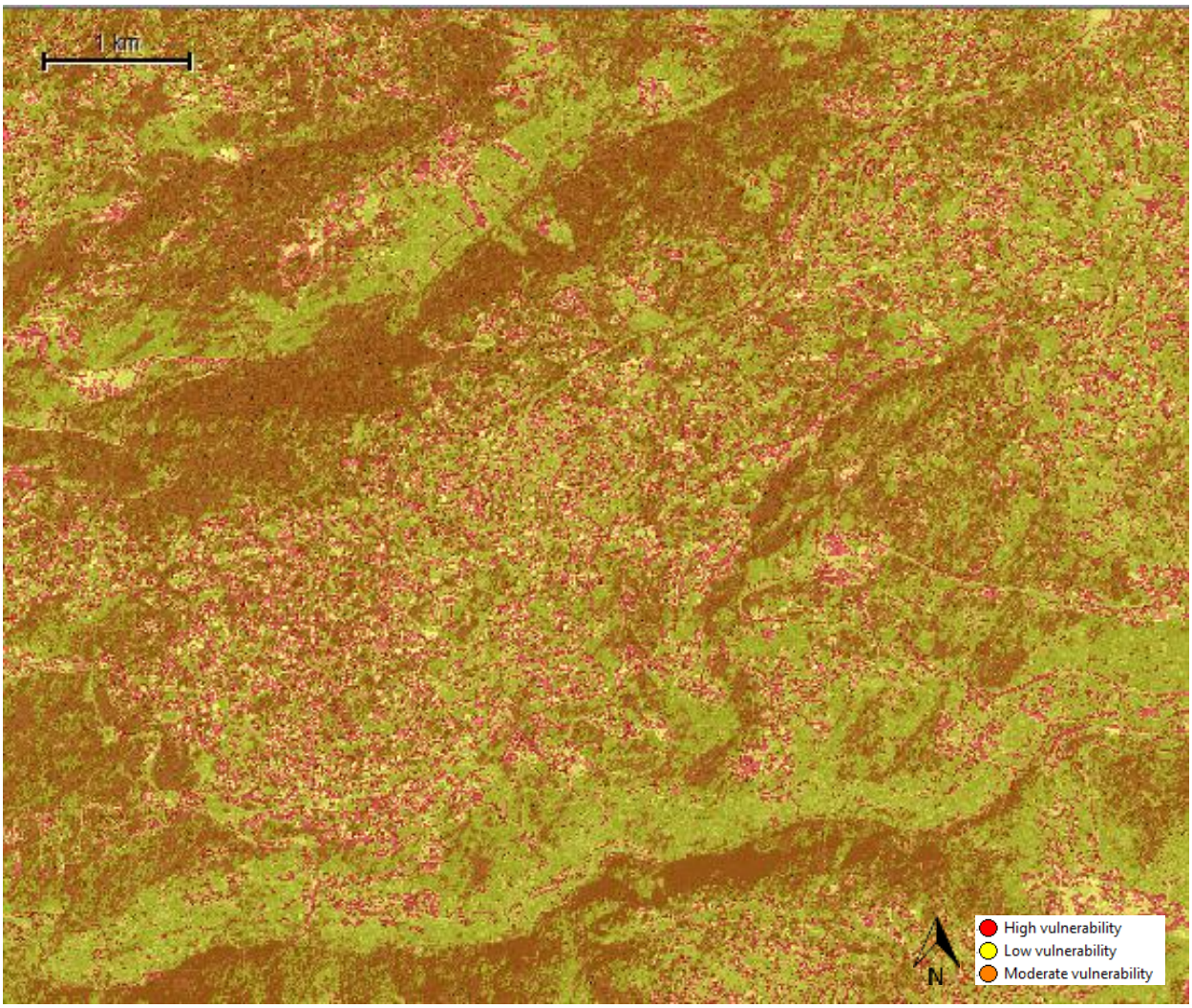


Figure 38. Fire vulnerability map of Ajaltoun and its surrounding

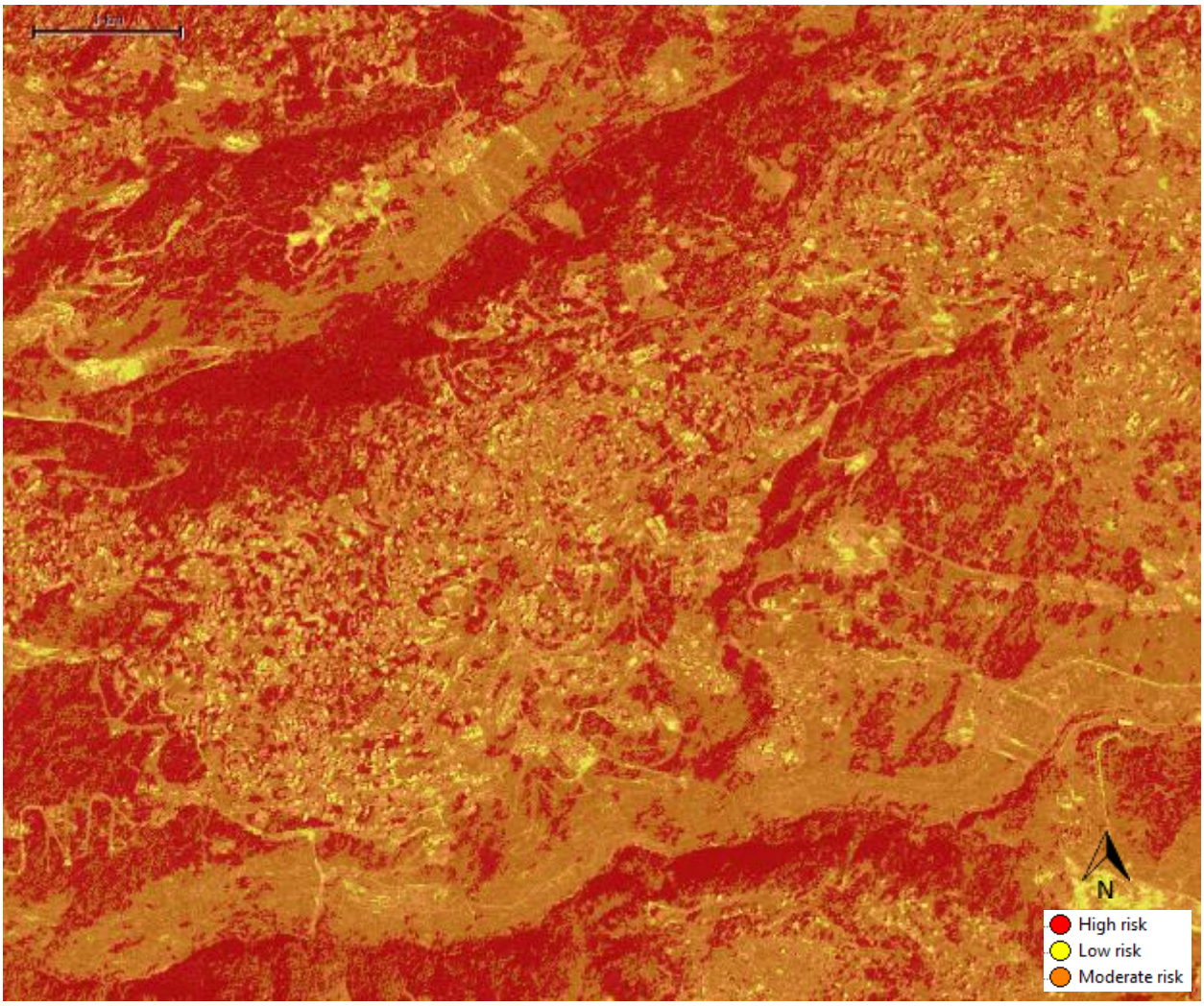


Figure 39. Fire risk map of Ajaltoun and its surrounding

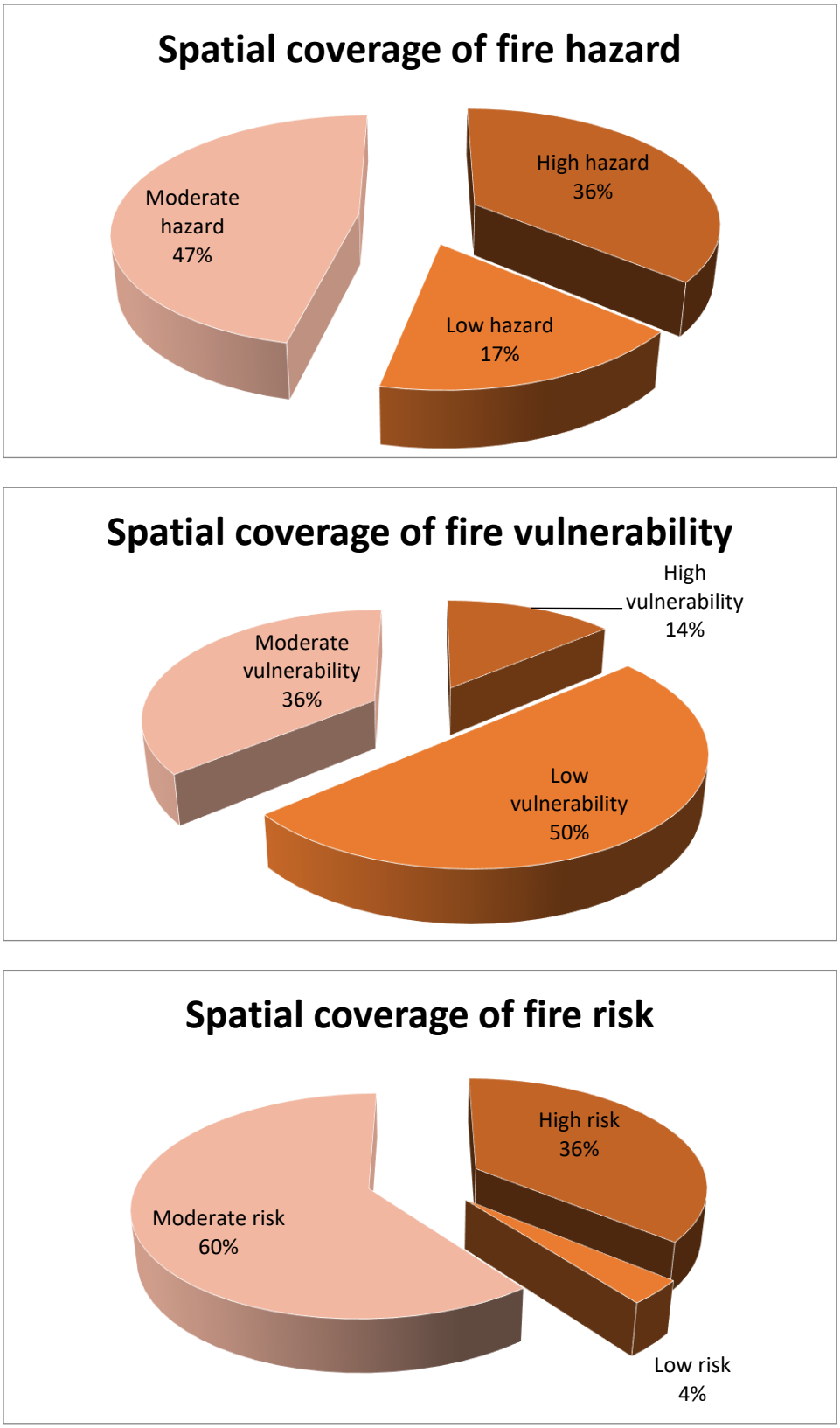


Figure 40. Spatial coverage of fire hazard (upper), vulnerability (middle), and risk (lower) classes

Bentael:

Three maps were produced, namely, fire hazard, vulnerability and risk (**Figure 41**, **Figure 42**, and **Figure 43**). Observations from the classification results were as follows:

- The total area of the Reserve is classified as 'high hazard' due to presence of dense vegetation cover. In addition, the Reserve is located on a south-aspect slope leading to an increased fire hazard.
- The total area of the Reserve is classified as 'high vulnerability' being primarily declared as Nature Reserve of benefit to the environment and to local communities (e.g. ecotourism activities). Most recently, an eco-park called the 'Greenshell' was launched on the upper northern border of the Reserve.
- At least 40% of the Reserve is classified as 'very high risk' mainly extending to the southern and western part of the Reserve. It is to be noted that the Reserve is bordered to the west and to the south by highly flammable shrubland. In addition, the new road to the south of the Reserve will increase the risk of fire occurrence (especially in case of littering, increased human access, possible burning of wastes and possible arson fires). It is worth noting that the Reserve is also prone to prevailing West-East winds across the slope.

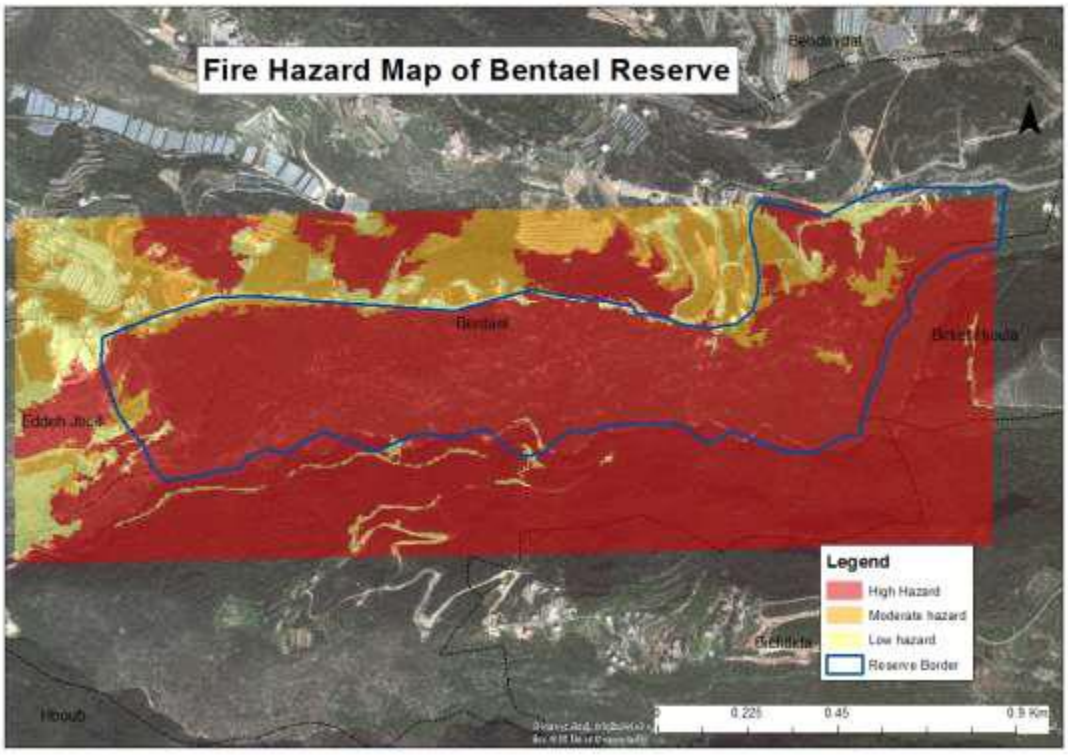


Figure 41. Fire hazard map of Bentael Nature Reserve and its surrounding

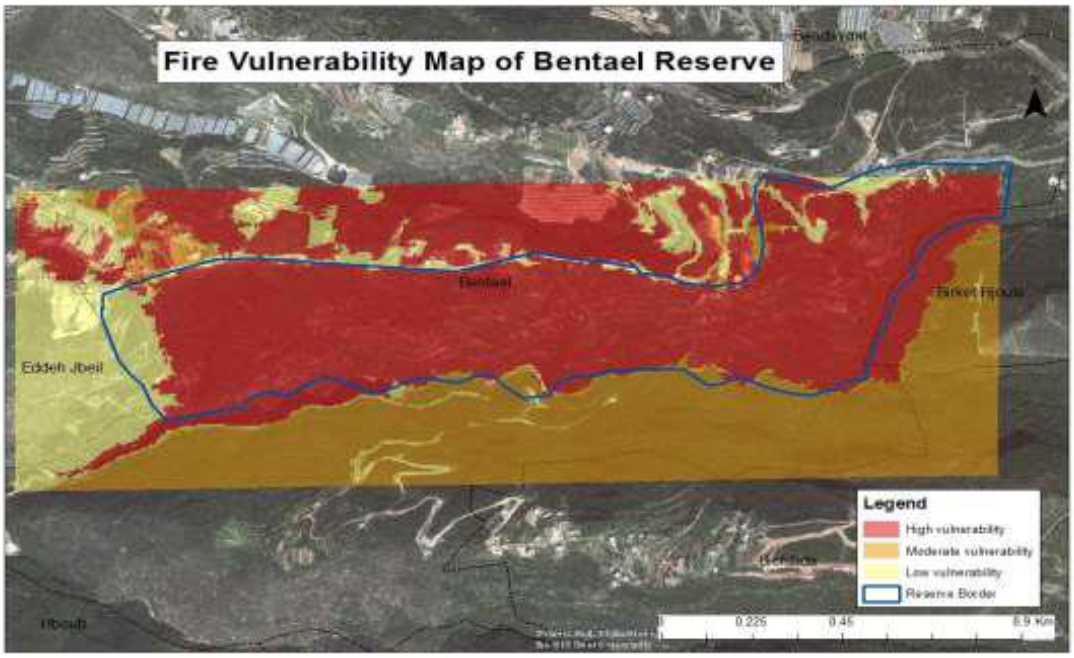


Figure 42. Fire vulnerability map of Bentael Nature Reserve and its surrounding

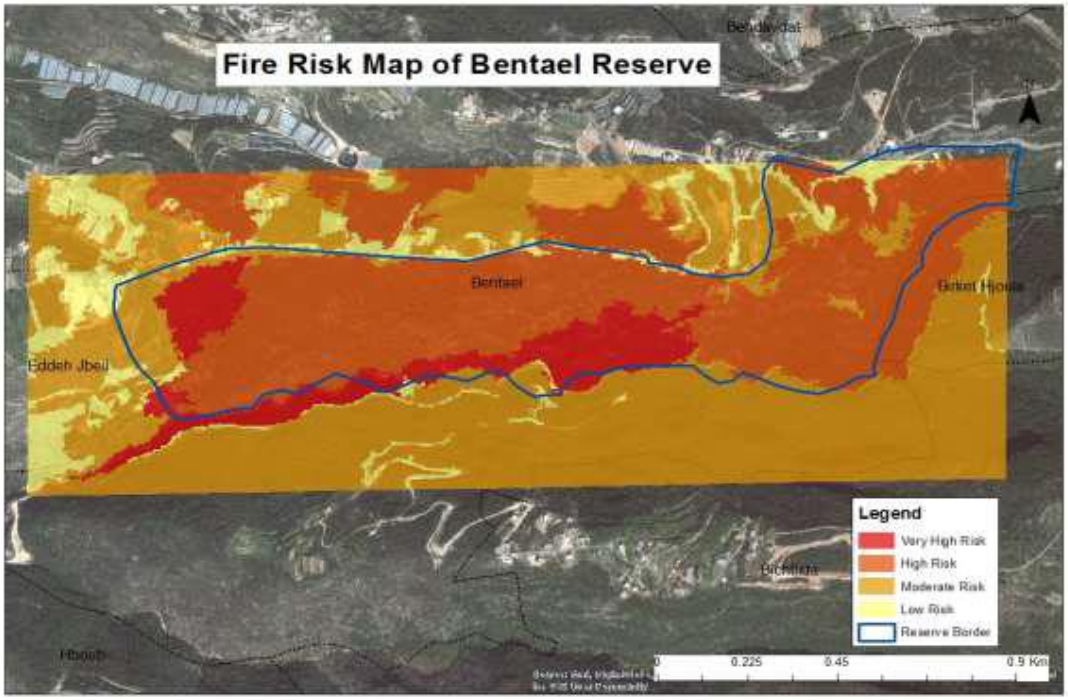


Figure 43. Fire risk map of Bentael Nature Reserve and its surrounding

Bkessine:

Three maps were produced, namely, fire hazard, vulnerability and risk (**Figure 44**, **Figure 45**, and **Figure 46**). Observations from the classification results were as follows:

- Around 80% of the Bkessine forest was classified as 'high hazard', while the remaining parts (e.g. west-south of the forest) were classified as moderate hazard. It is to be noted that the class 'moderate hazard' was mainly attributed to areas of moderate density of pine trees and understory vegetation.
- The total extent of the forest was classified as 'high vulnerability' due to its importance as a managed forest from which the local community extracts a lot of economic benefits (e.g. collecting pine seeds, gathering fuelwood from pruning activities and implementing ecotourism activities). In addition, new ecotourism investments, the camping site and "La Maison de La Forêt" increased the vulnerability in the area.
- Around 40% of the forest was classified as 'very high risk', 30% as 'high risk', and 30% as 'moderate risk'. High risk areas were mainly located on the eastern part of the forest and surrounding ravines which are extending on steep slopes and comprising unmanaged dense vegetation cover.

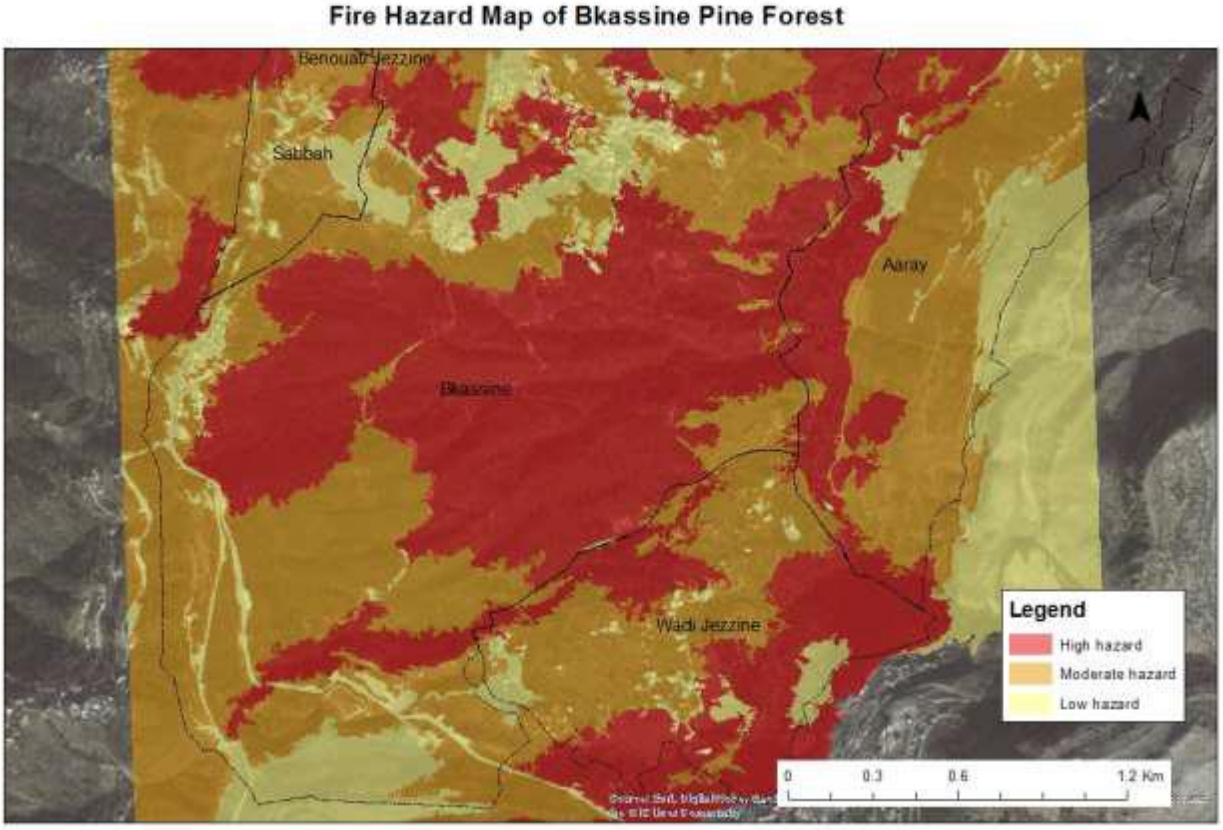


Figure 44. Fire hazard map of Bkessine

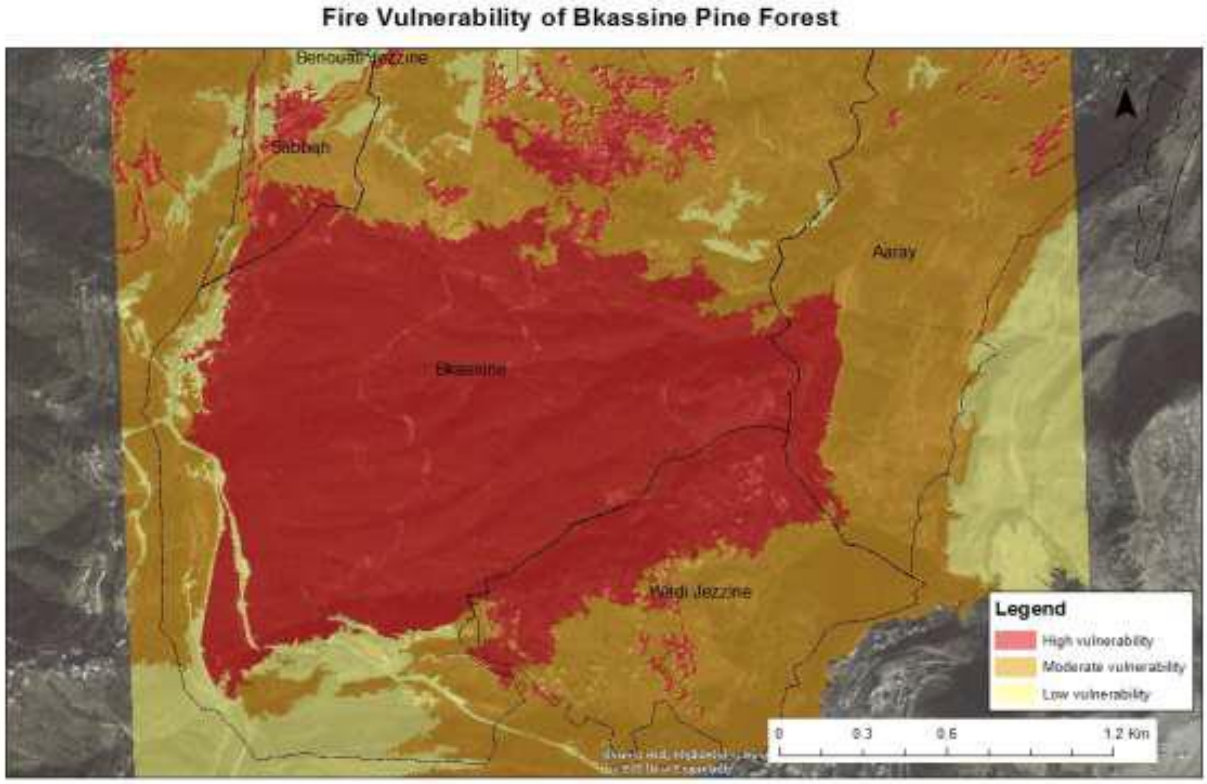


Figure 45. Fire vulnerability map of Bkessine

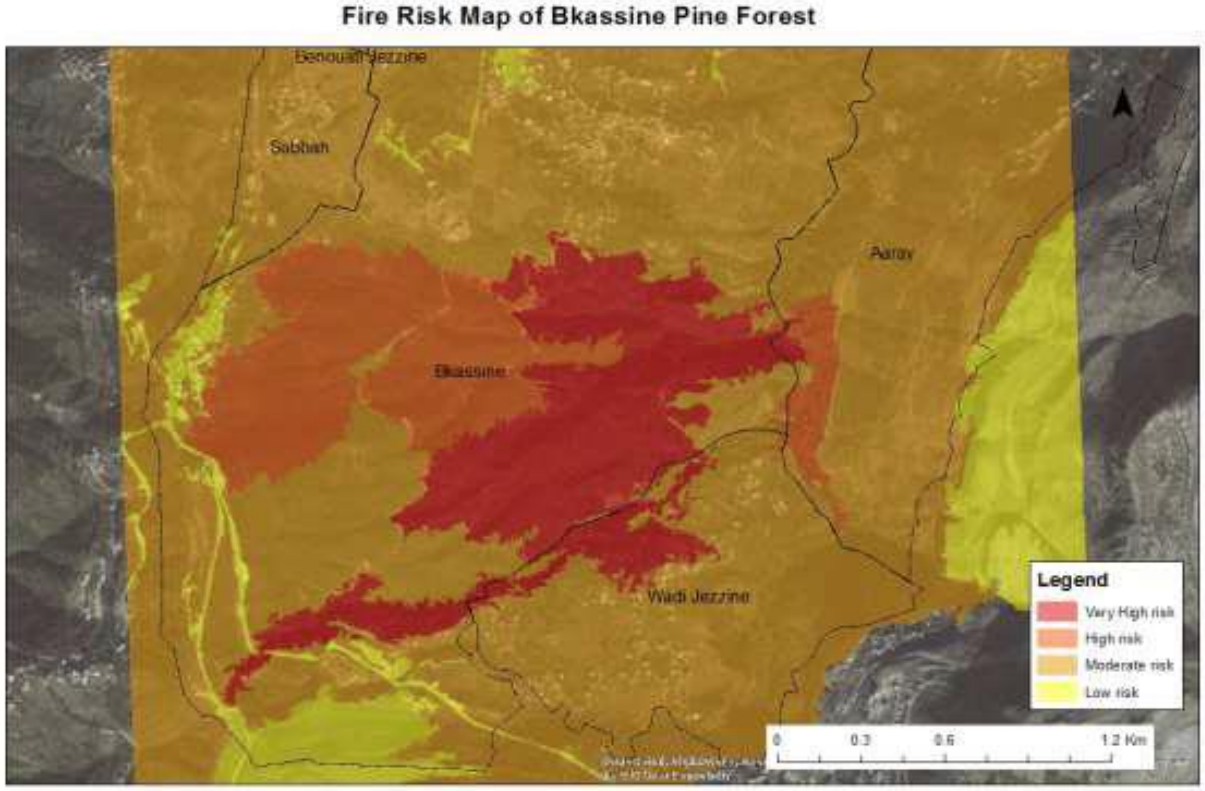


Figure 46. Fire risk map of Bkessine

Deir El Ahmar:

Three maps were produced, namely, fire hazard, vulnerability, and risk (**Figure 47**, **Figure 48**, and **Figure 49**). Percentages of spatial coverage of classified classes are provided in **Figure 50**. Observations from the classification results were as follows:

- Around 27% of the study area was classified as high hazard, while the remaining parts were classified as moderate to low hazard. It is to be noted that the class high hazard was mainly attributed to areas covered by relatively thick and dense oak trees. Also, parts of vegetated agricultural lands were classified as high hazard.
- Around 35% of the total area of interest was classified as high vulnerability. High vulnerability areas represented mainly houses and infrastructures located close to dense forest fuel and cultivated agricultural lands. In addition, forested areas covered by dense oak trees were classified as lands of high vulnerability.
- Around 24% of the total area was classified as high risk which represented mainly the highly dense vegetated cover, in addition to highly combustible fuel in the Wildland-Urban Interface. Agricultural lands especially those on the flat terrain were mainly classified as moderate risk lands.

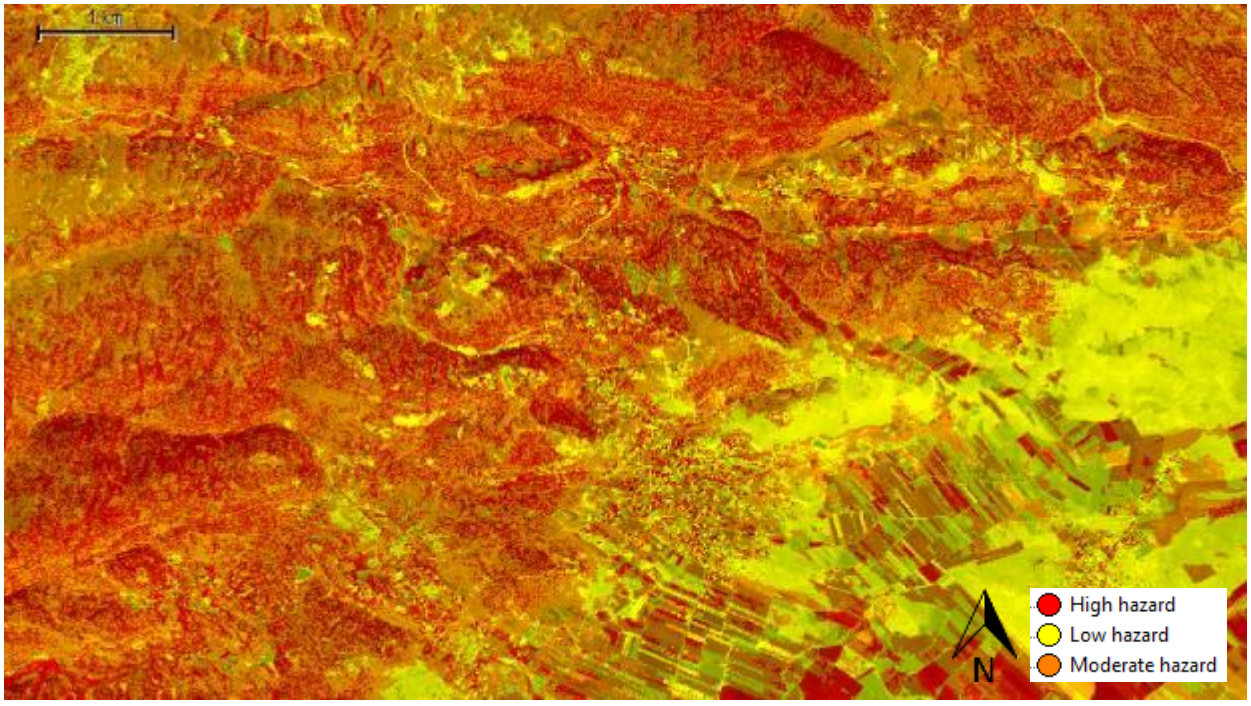


Figure 47. Fire hazard map of DA and its surrounding

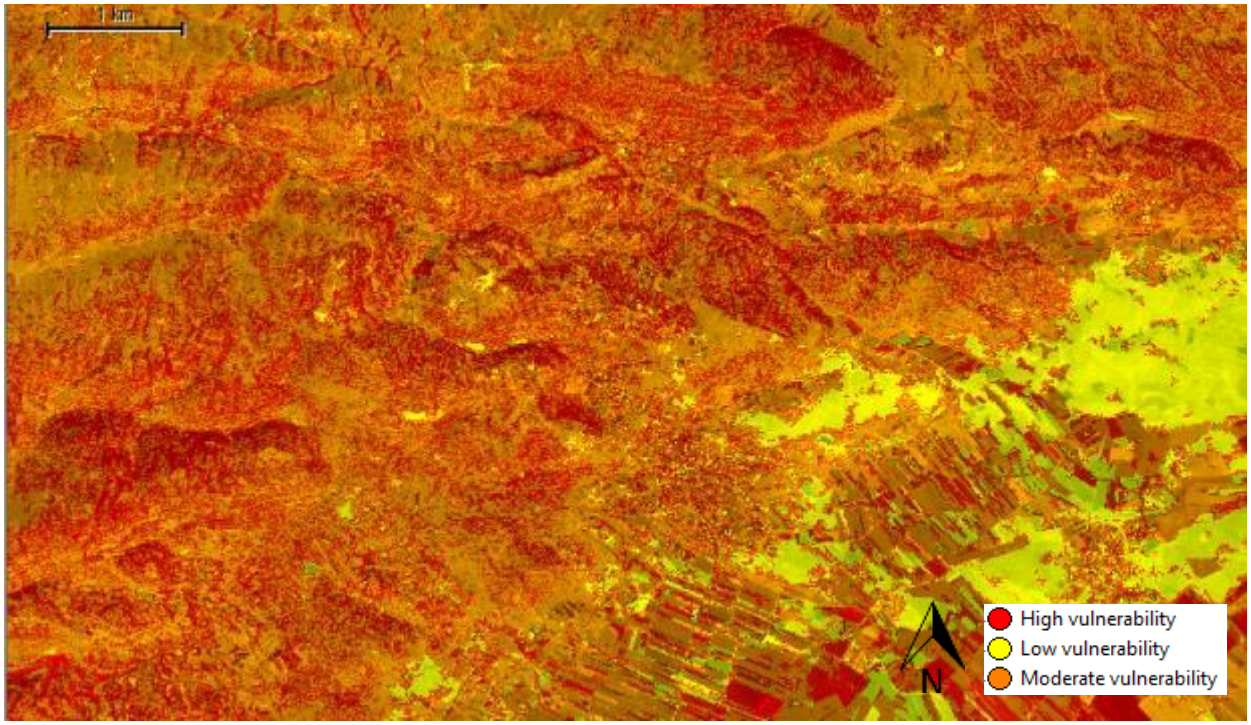


Figure 48. Fire vulnerability map of DA and its surrounding

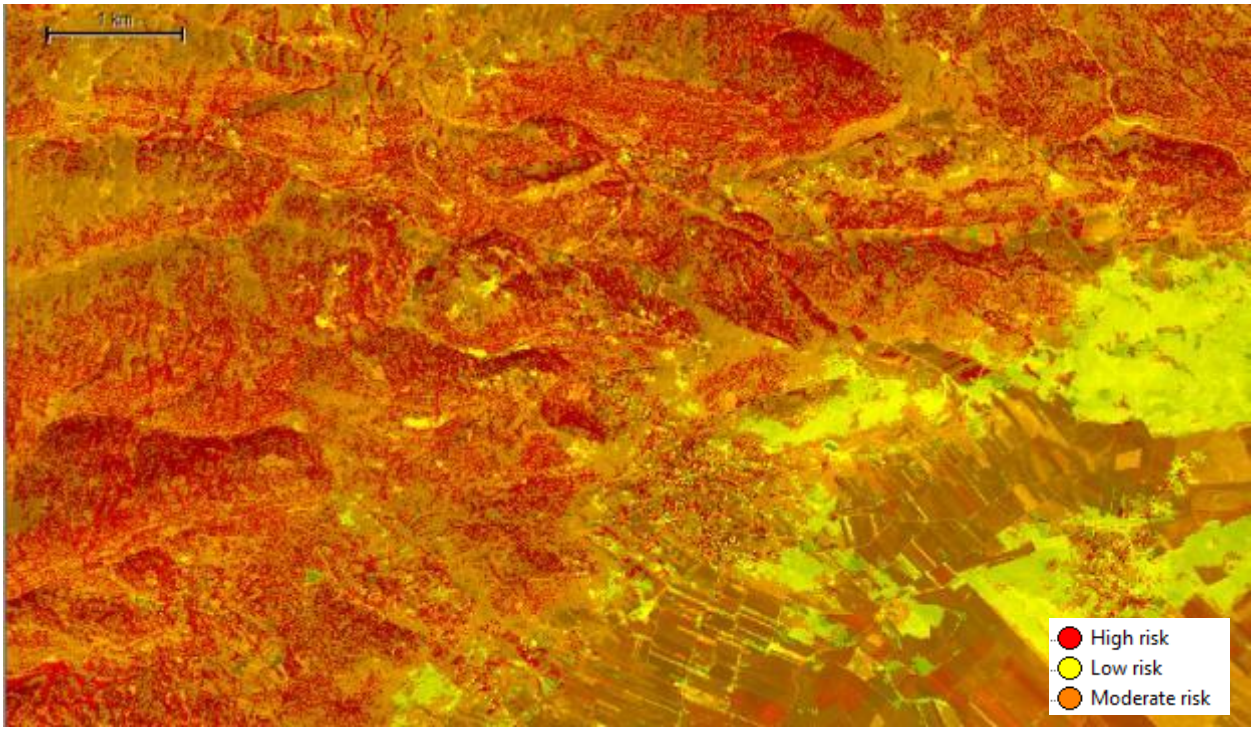
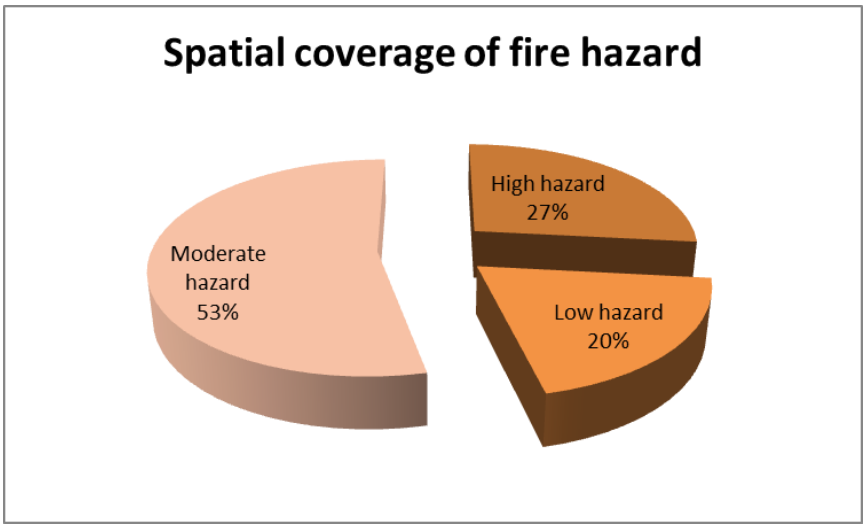
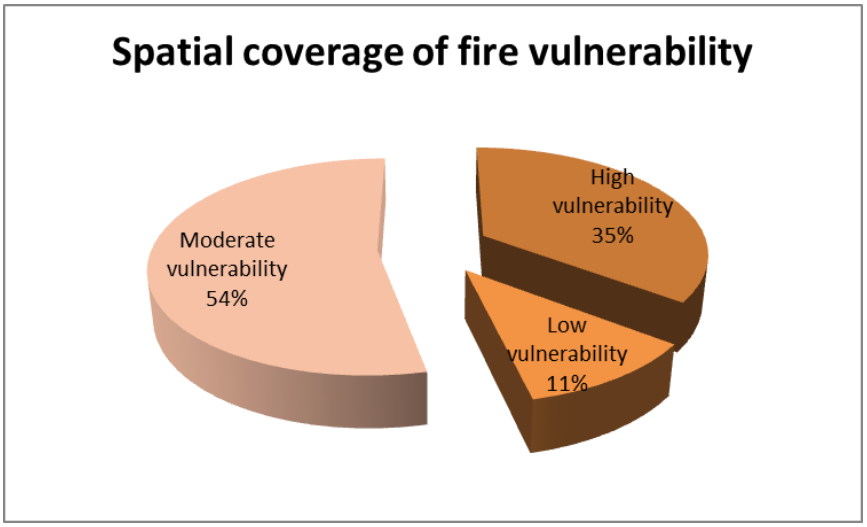


Figure 49. Fire risk map of DA and its surrounding





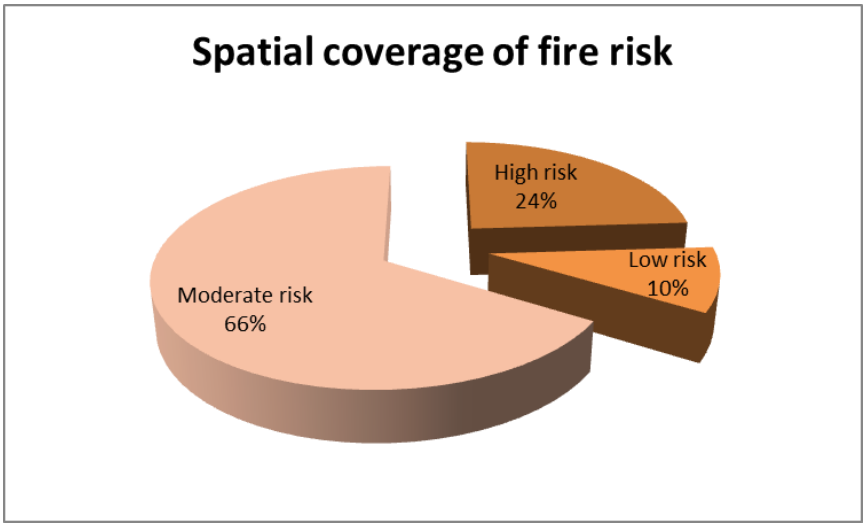


Figure 50. Spatial coverage of fire hazard (upper), vulnerability (middle), and risk (lower) classes

Hamat/Wajh El Hajar:

Three maps were produced, namely, fire hazard, vulnerability and risk (**Figure 51**, **Figure 52**, and **Figure 53**). Percentages of spatial coverage of classified classes are provided in **Figure 54**. Observations from the classification results were as follows:

- Around 48% of the study area was classified as 'high hazard', while the remaining parts were classified as moderate to low hazard. It is to be noted that the class 'high hazard' was mainly attributed to areas covered by relatively thick and dense forest oak forest with potential of developing a dense forest stand.
- Around 74% of the total area of interest was classified as 'high vulnerability'. High vulnerability areas represented mainly agricultural lands, burned areas, in addition to settlements and infrastructure neighboring fire hazard areas. In addition, the dense oak forest was classified as land of high vulnerability due to is potential in benefiting the local community with wood and non-wood products.
- Around 46% of the total area was classified as 'high risk' which represented mainly the highly dense vegetated cover, in addition to vegetated cropland/agricultural land.

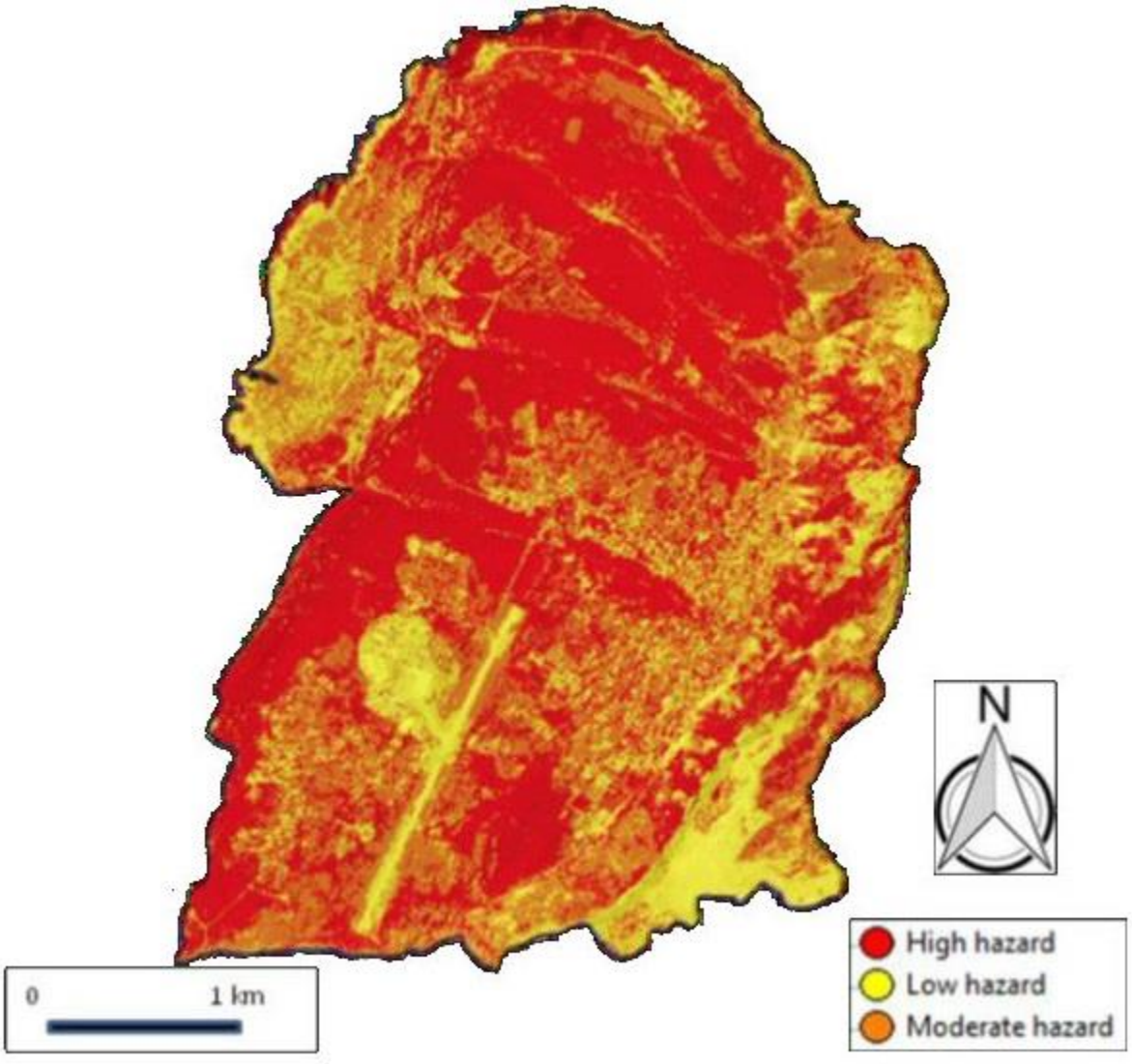


Figure 51. Fire hazard map of Hamat/Wajh el Hajar

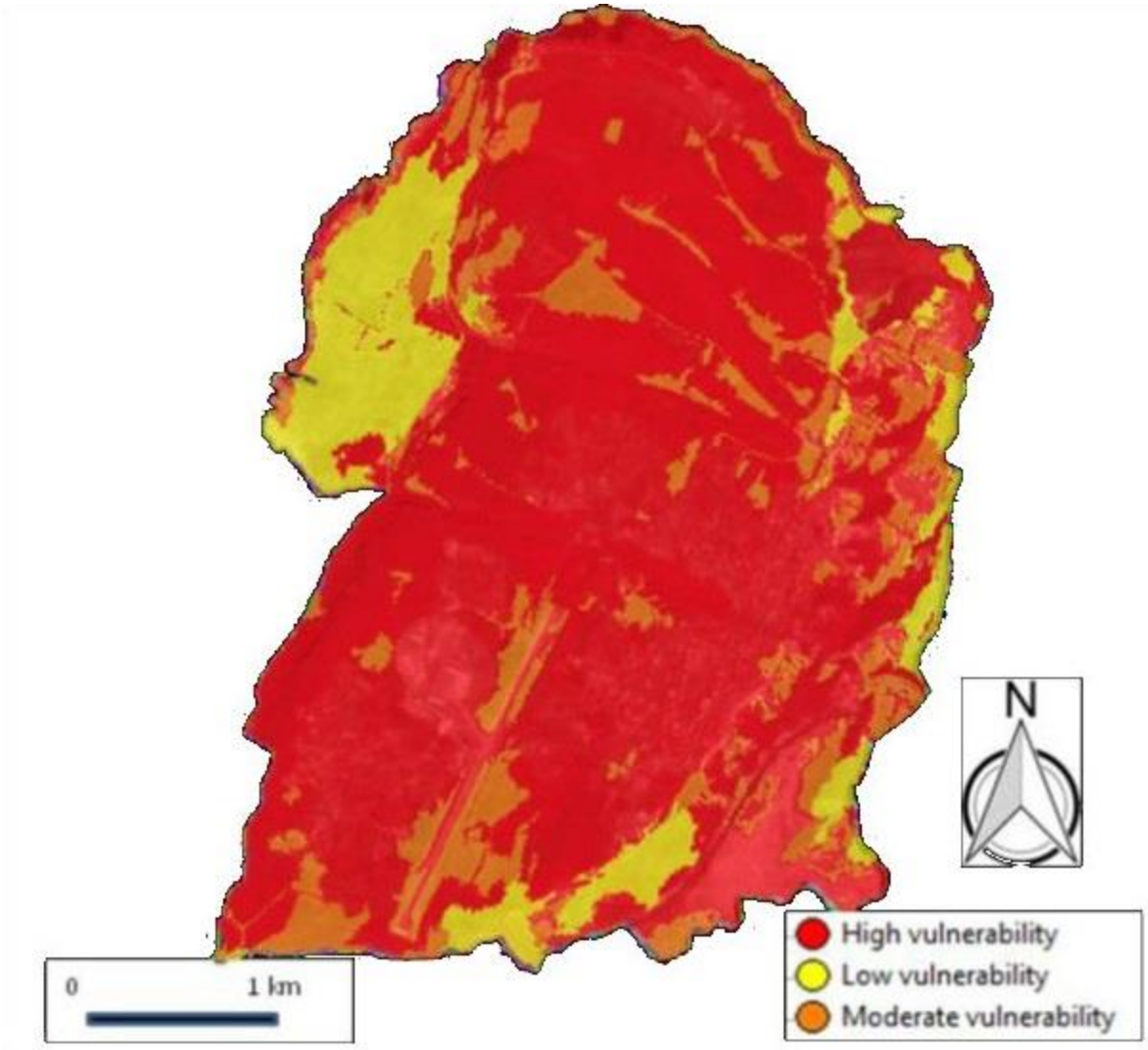


Figure 52. Fire vulnerability map of Hamat/Wajh el Hajar

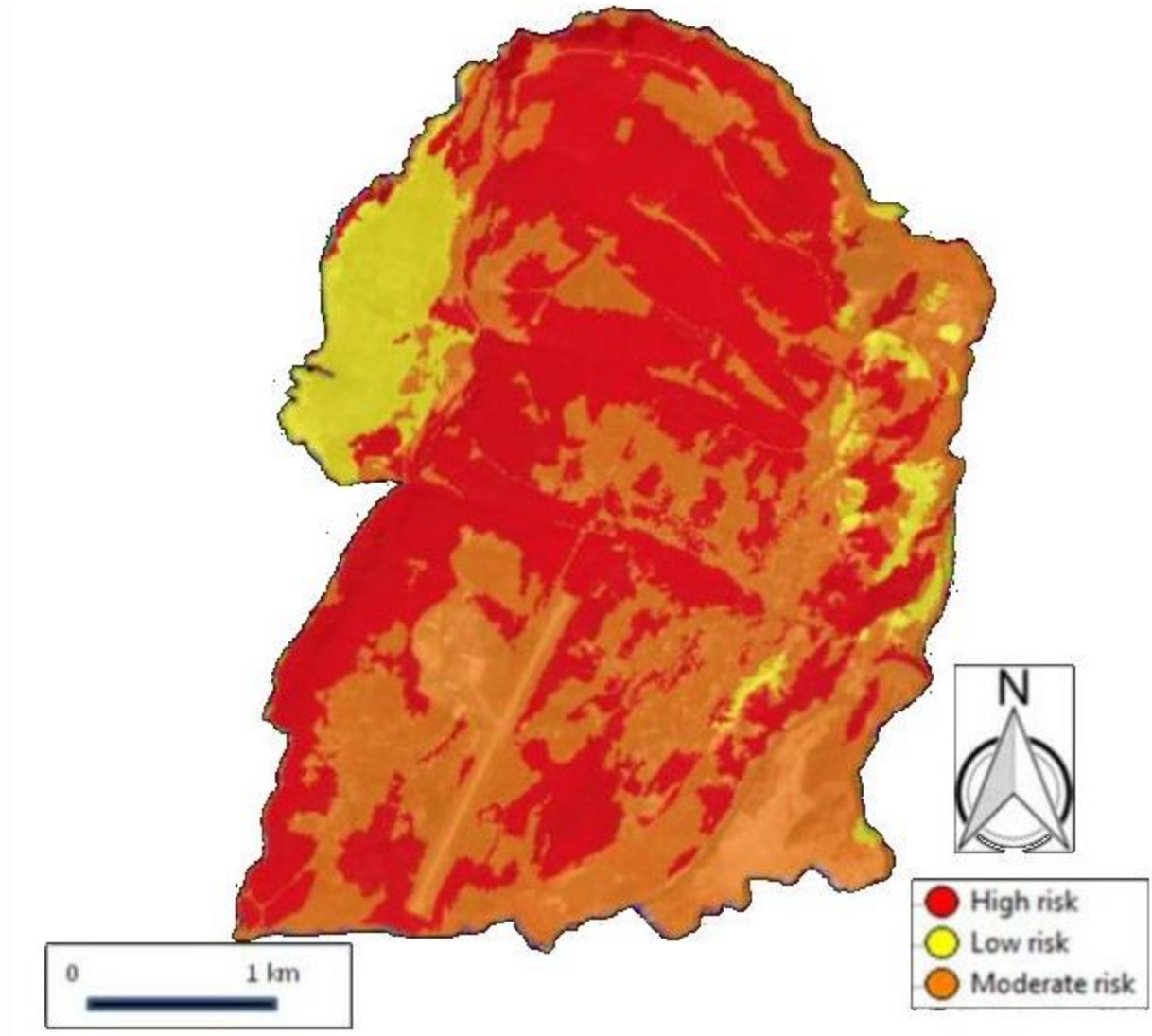


Figure 53. Fire risk map of Hamat/Wajh el Hajar

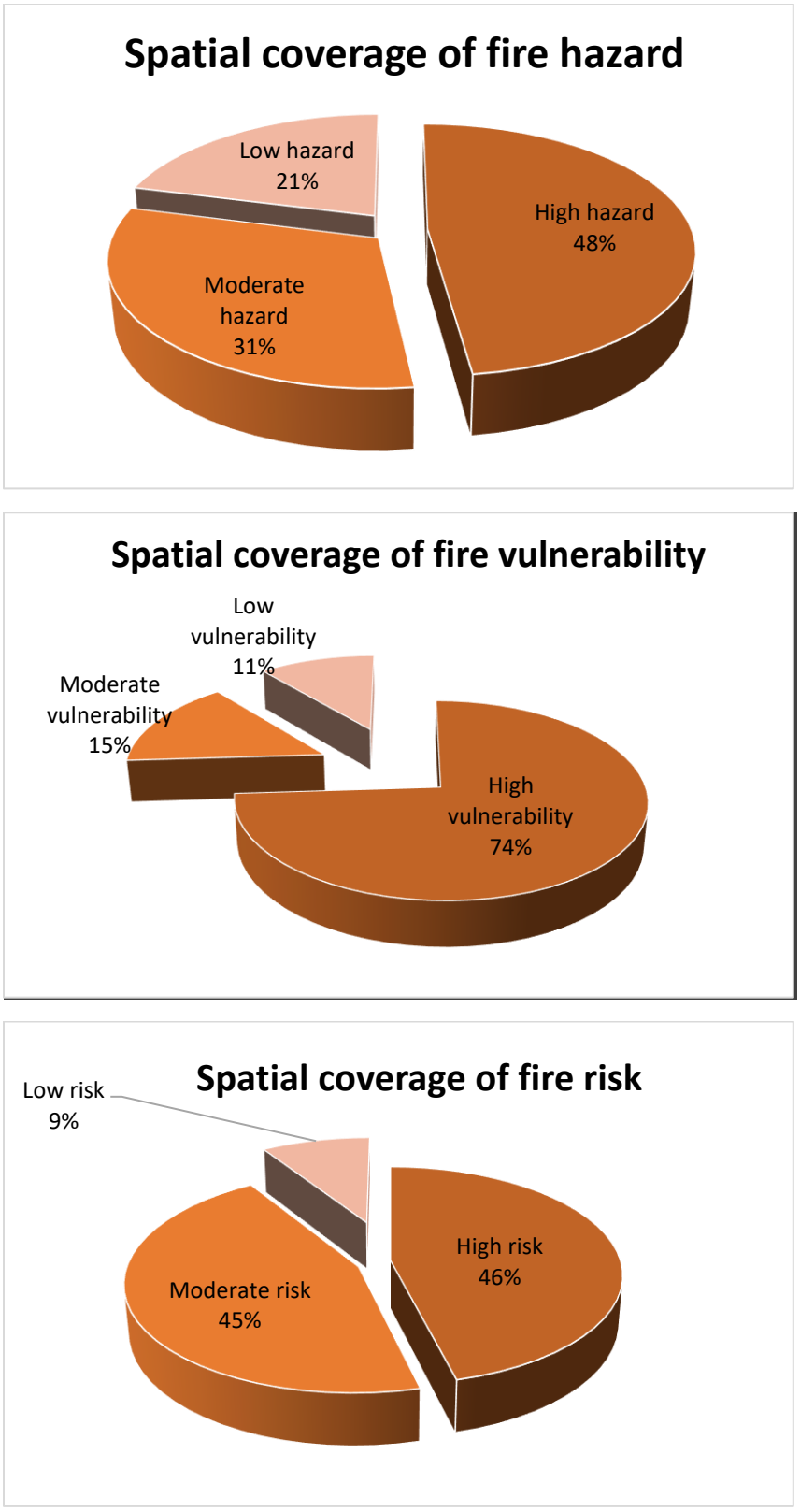


Figure 54. Spatial coverage of fire hazard (upper), vulnerability (middle), and risk (lower) classes

Jabal Moussa:

Three maps were produced, namely, fire hazard, vulnerability and risk (**Figure 55**, **Figure 56**, and **Figure 57**). Percentages of spatial coverage of classified classes are provided in **Figure 58**. Observations from the classification results were as follows:

- Around 34% of the JM and its surrounding were classified as 'high hazard', while the remaining parts were classified as 'moderate to low hazard'. It is to be noted that the class 'high hazard' was mainly attributed to areas covered by thick vegetation forest fuel.
- Around 47% of the total area of interest was classified as 'moderate to high vulnerability'. High vulnerability areas characterized mainly the core area of JM Biosphere Reserve and its extended forested lands. Homes and infrastructures located close to forested area covered were classified as 'moderate to high vulnerability' depending on their surroundings.
- Around 46% of the area was classified as 'high risk' and 37% as 'moderate risk'. High risk areas represented mainly the core area of JM Biosphere Reserve and its extended forested lands, in addition to combustible thick forest fuel.

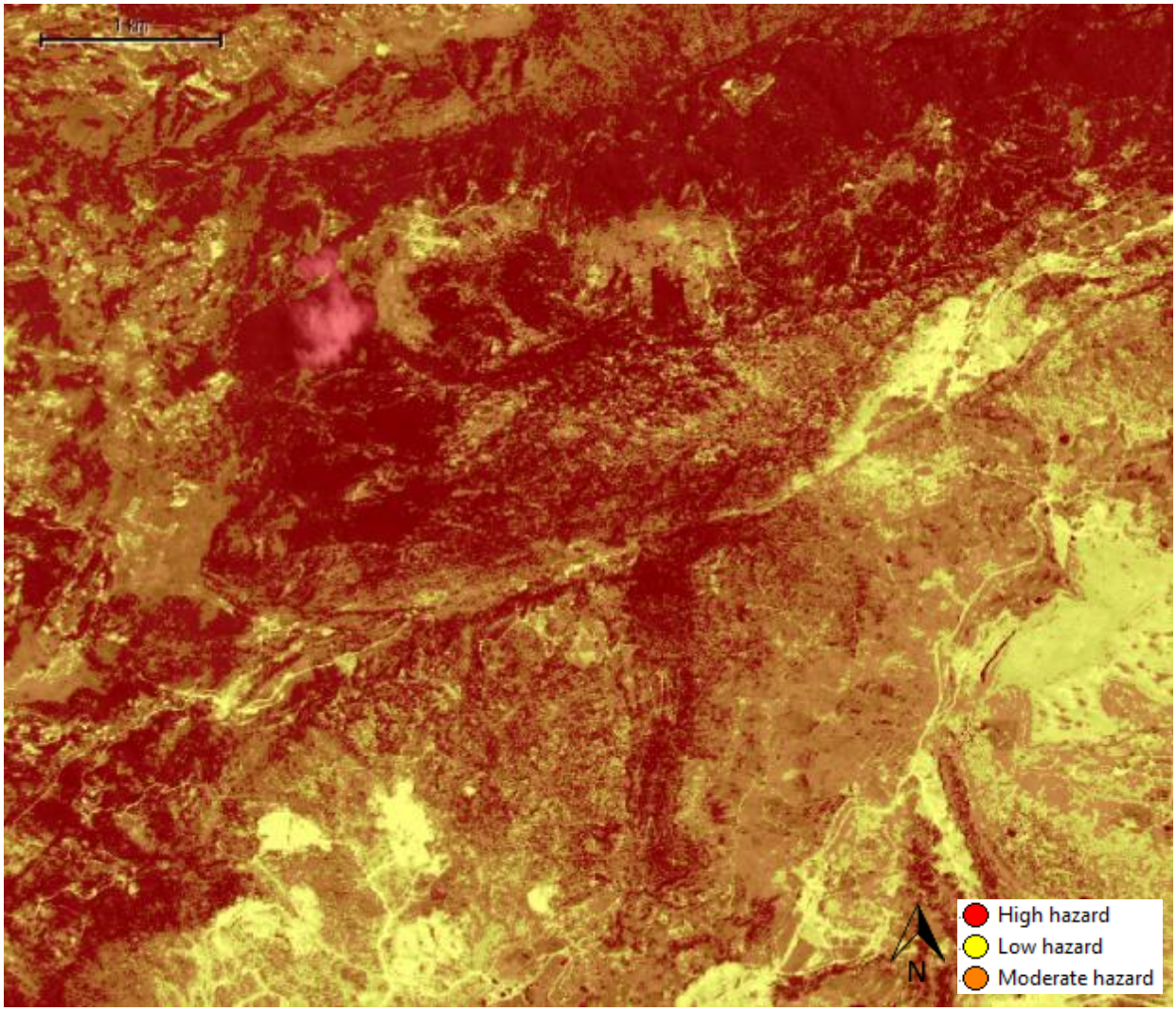


Figure 55. Fire hazard map of JM and its surrounding

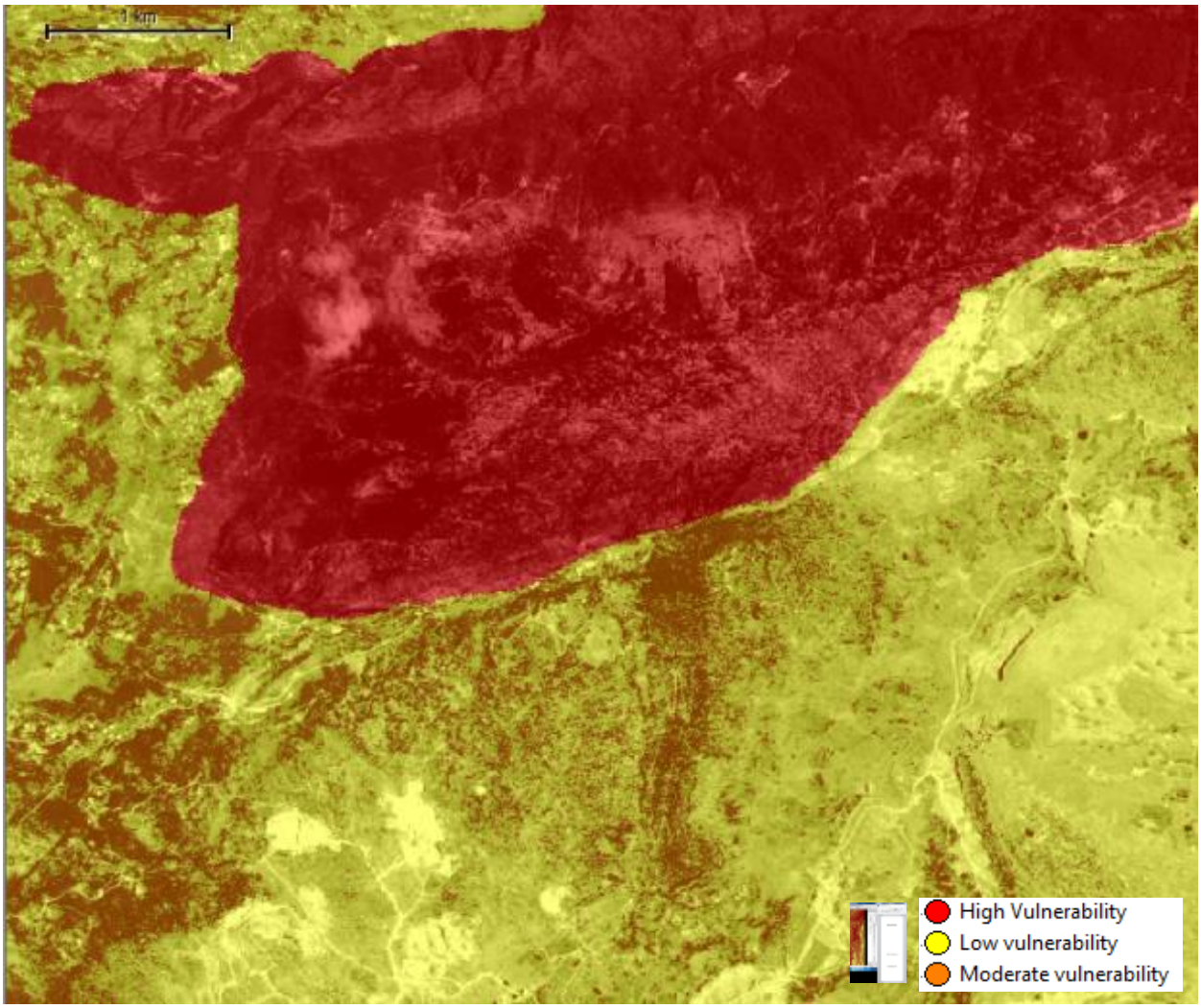


Figure 56. Fire vulnerability map of JM and its surrounding

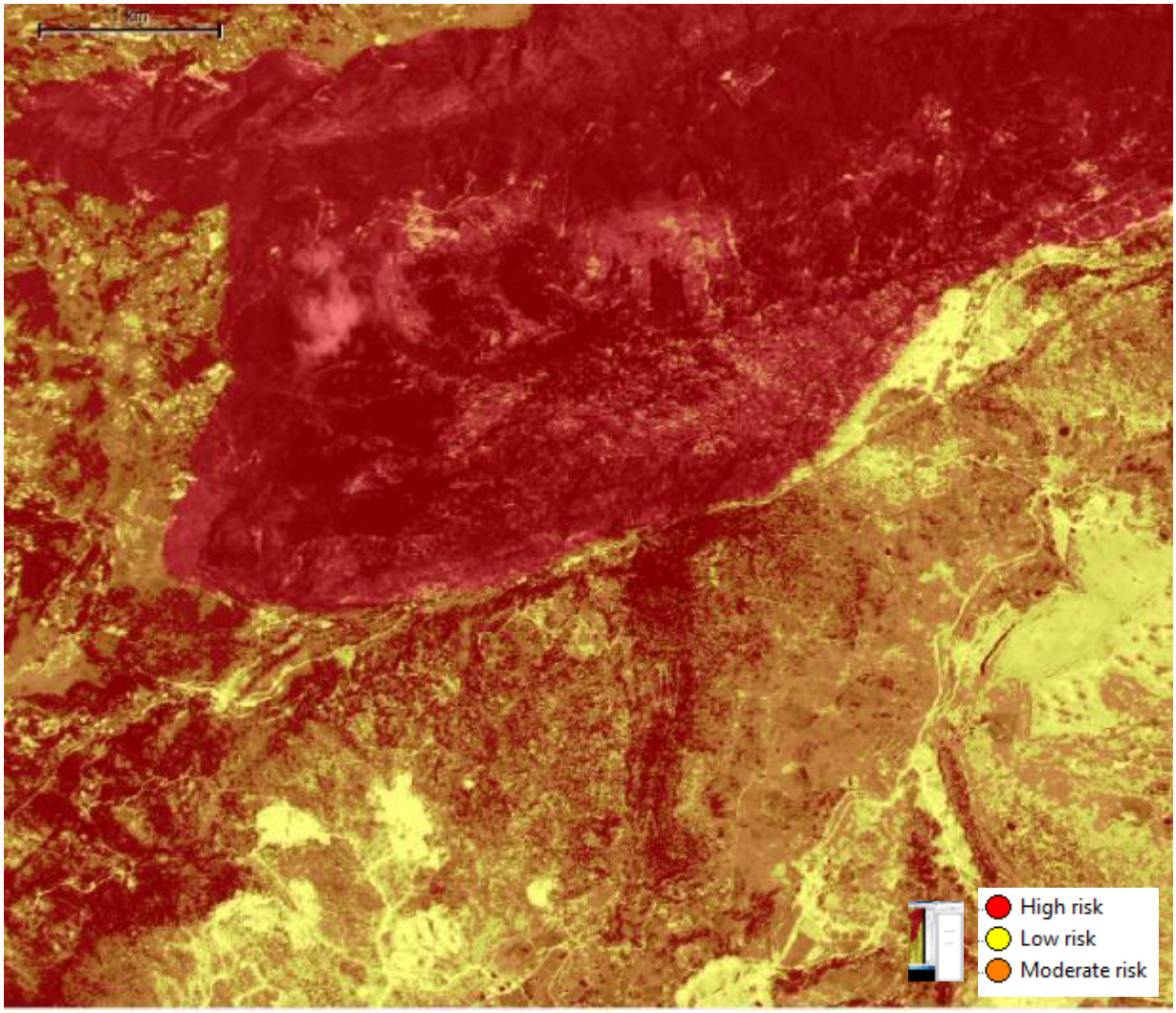
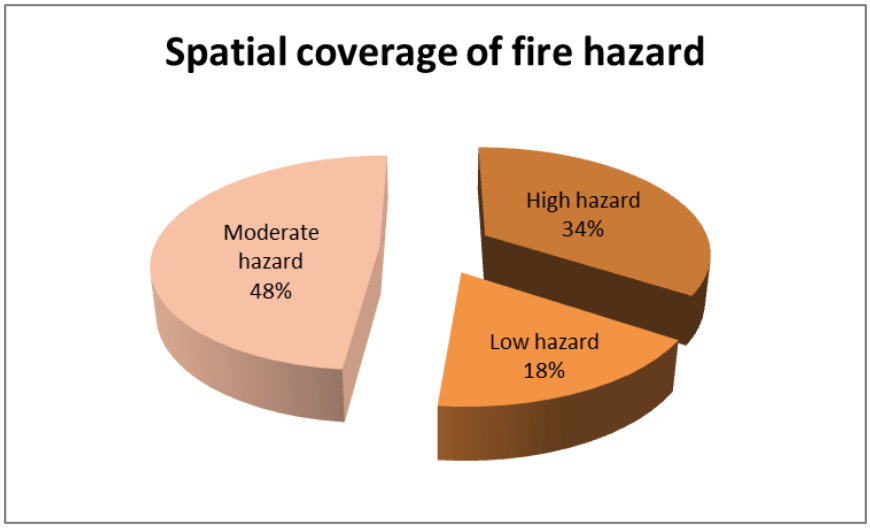


Figure 57. Fire risk map of JM and its surrounding



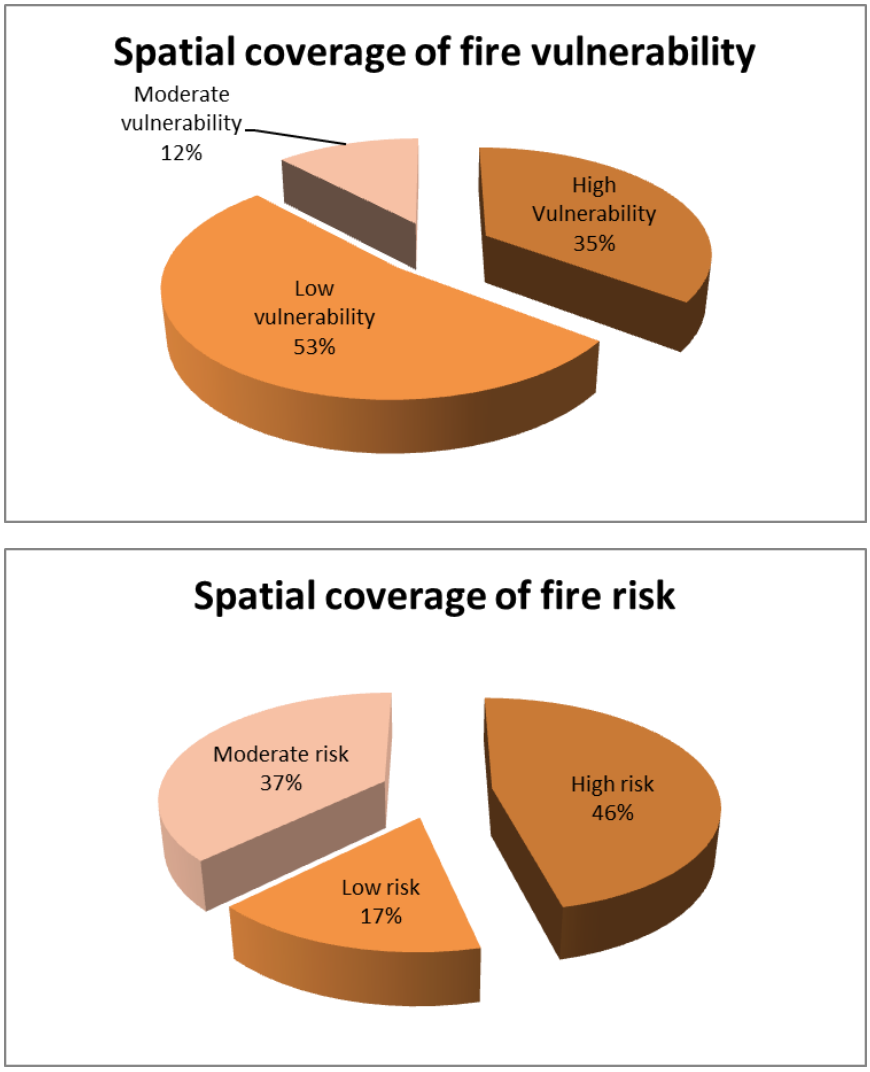


Figure 58. Spatial coverage of fire hazard (upper), vulnerability (middle), and risk (lower) classes

Menjez:

Three maps were produced, namely, fire hazard, vulnerability and risk (**Figure 59**, **Figure 60**, and **Figure 61**). Percentages of spatial coverage of classified classes are provided in **Figure 63**. Observations from the classification results were as follows:

- Around 12% of the study area was classified as 'high hazard', while the remaining parts were classified as 'moderate to low hazard'. It is to be noted that the class 'high hazard' was mainly attributed to areas covered by relatively thick and dense forest and/or areas with potential of developing a dense forest stand.
- Around 94% of the total area of interest was classified as 'high vulnerability'. High vulnerability areas represented mainly agricultural and reforested areas in addition to houses and infrastructures located close to densely vegetation areas. In addition, the dense oak and laurel forest was classified as land of high vulnerability due to is potential in benefiting the local community with wood and non-wood products.
- Around 9% of the total area was classified as 'high risk' which represented mainly the highly dense vegetated cover, in addition to recently reforested/afforested areas. Simultaneously, around 88% of the study area was classified as 'moderate vulnerability', representing mainly cropland.

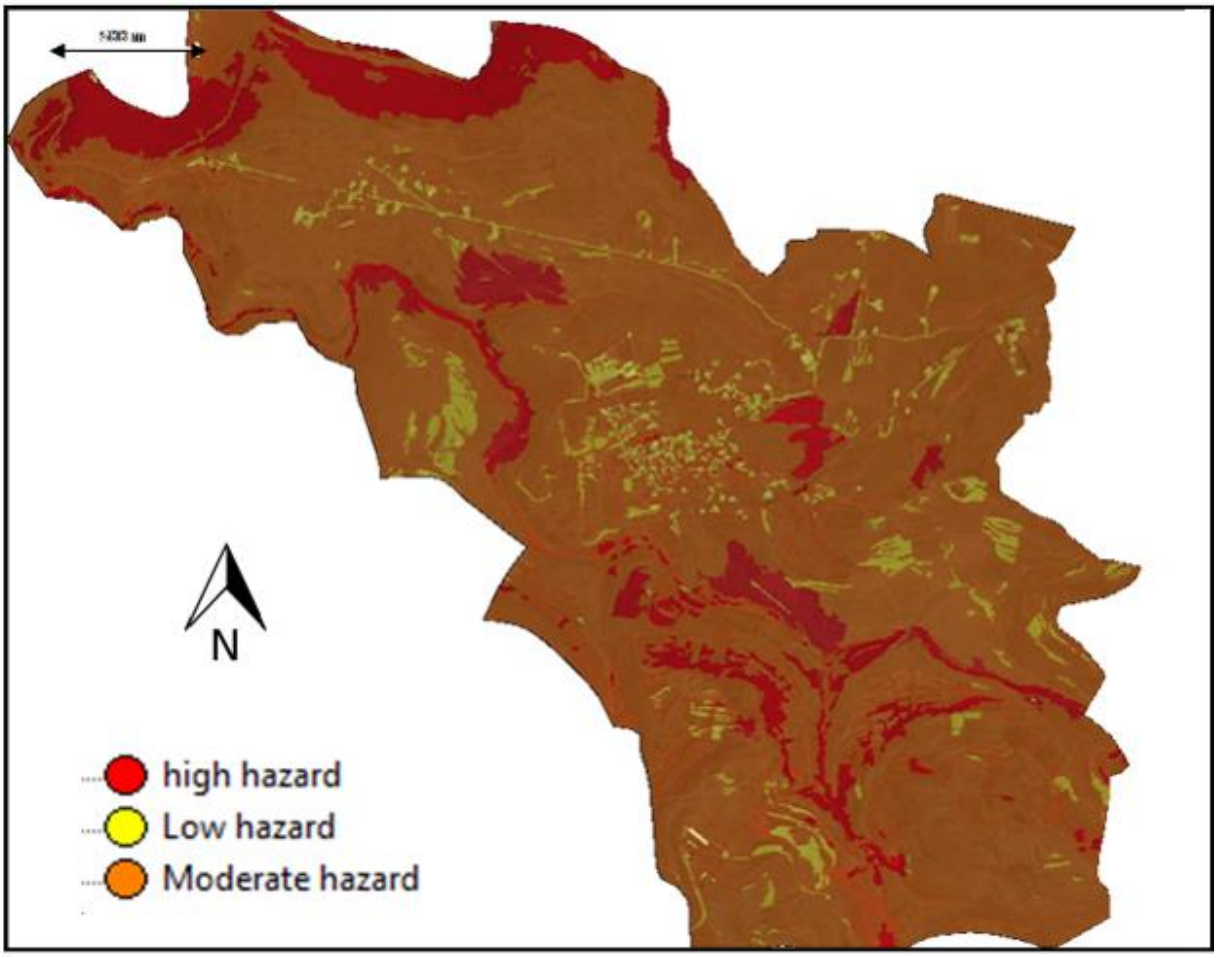


Figure 59. Fire hazard map of Menjez

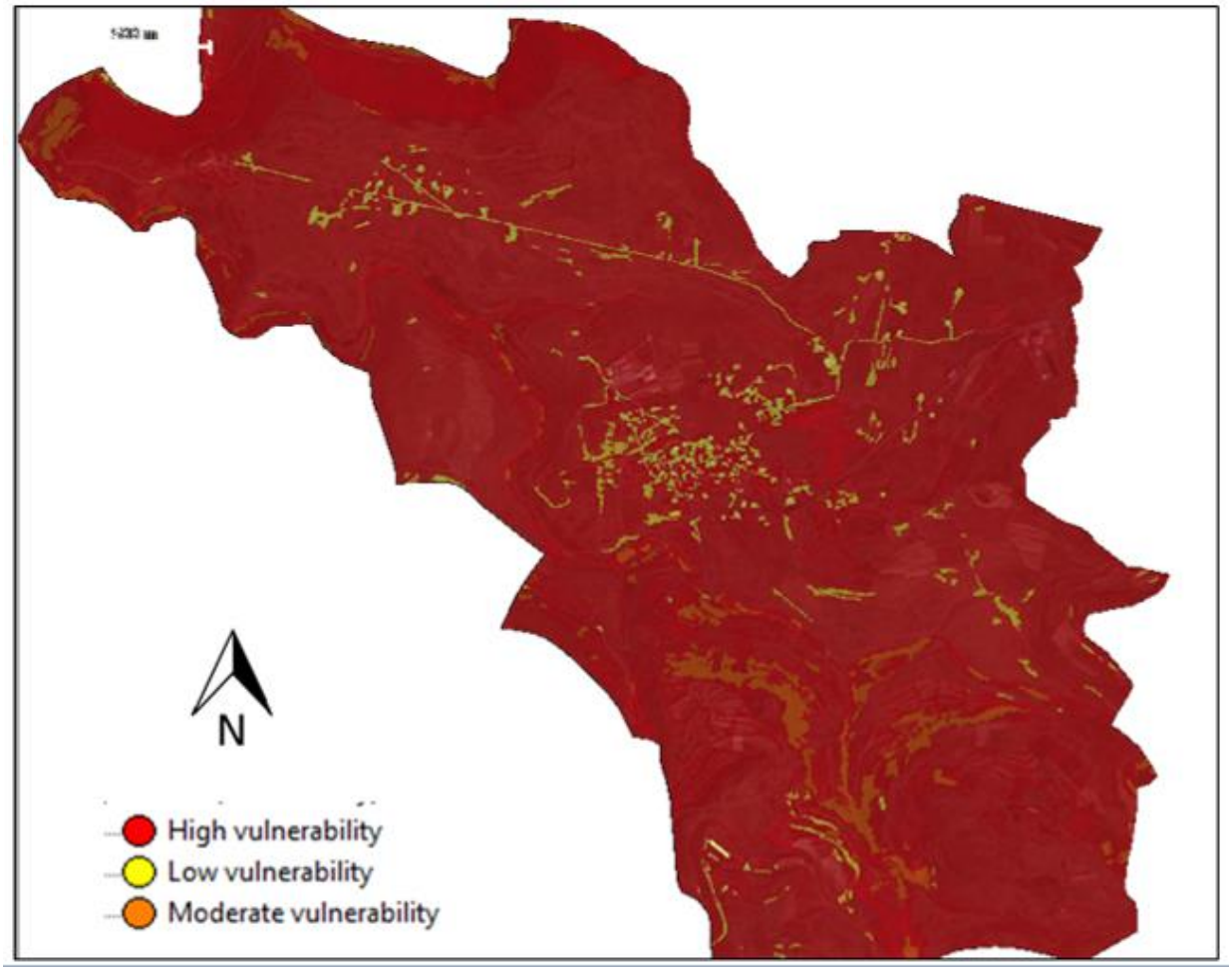


Figure 60. Fire vulnerability map of Menjez

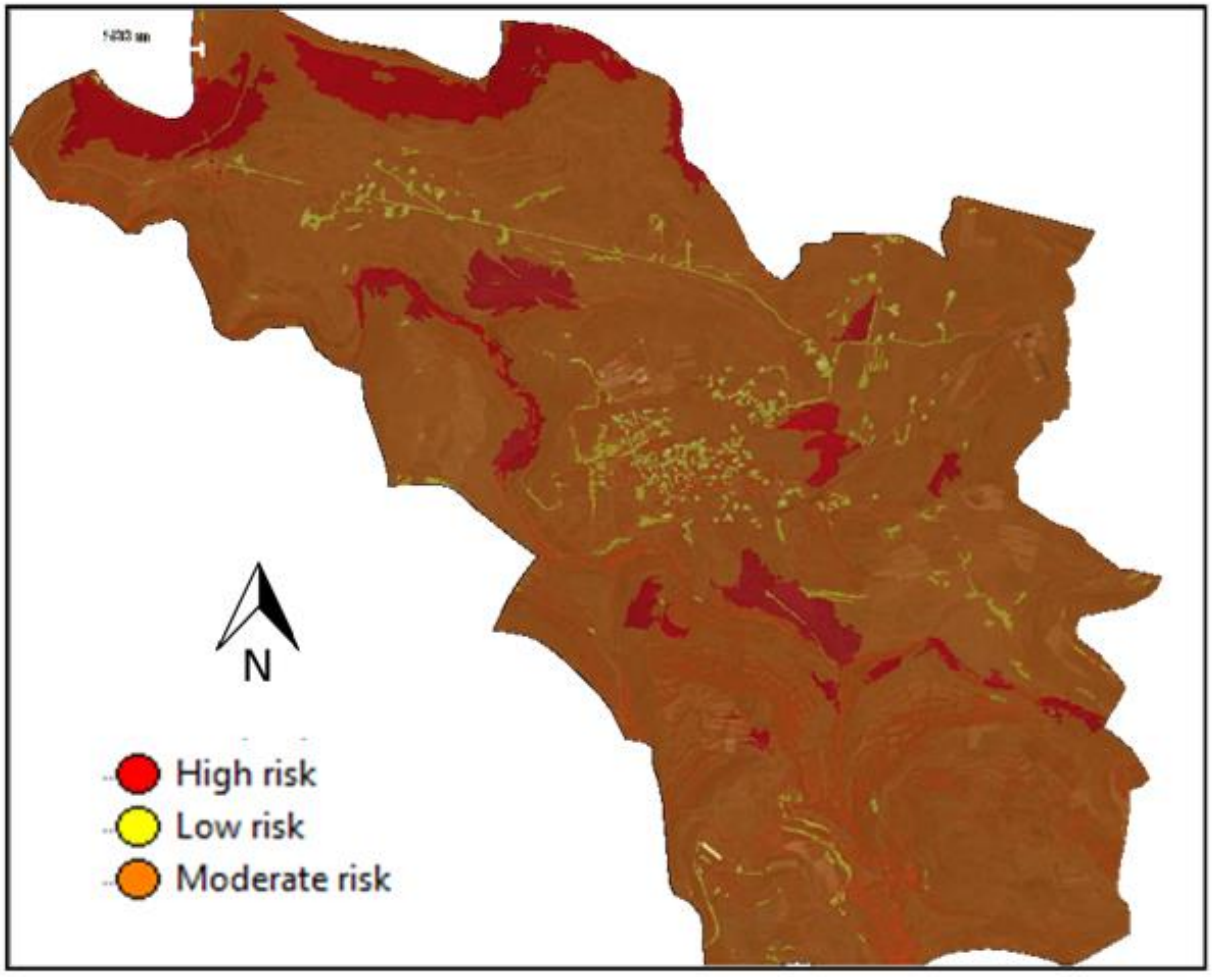
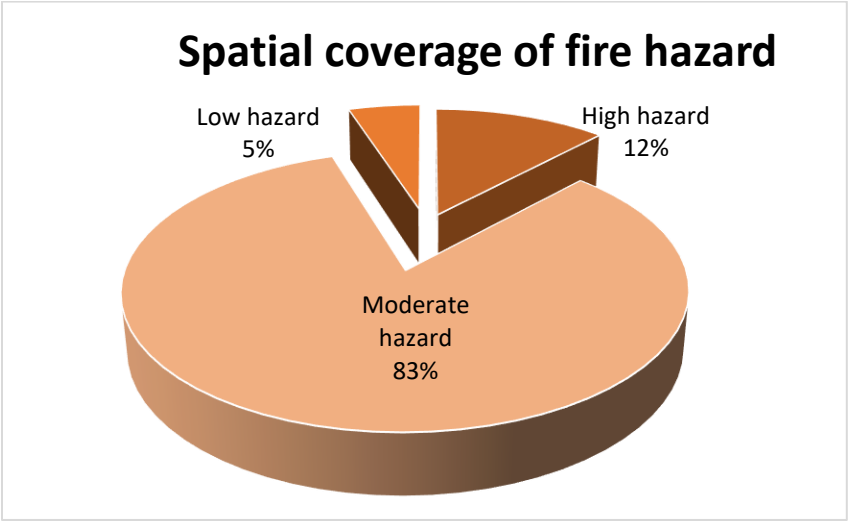


Figure 61. Fire risk map of Menjez



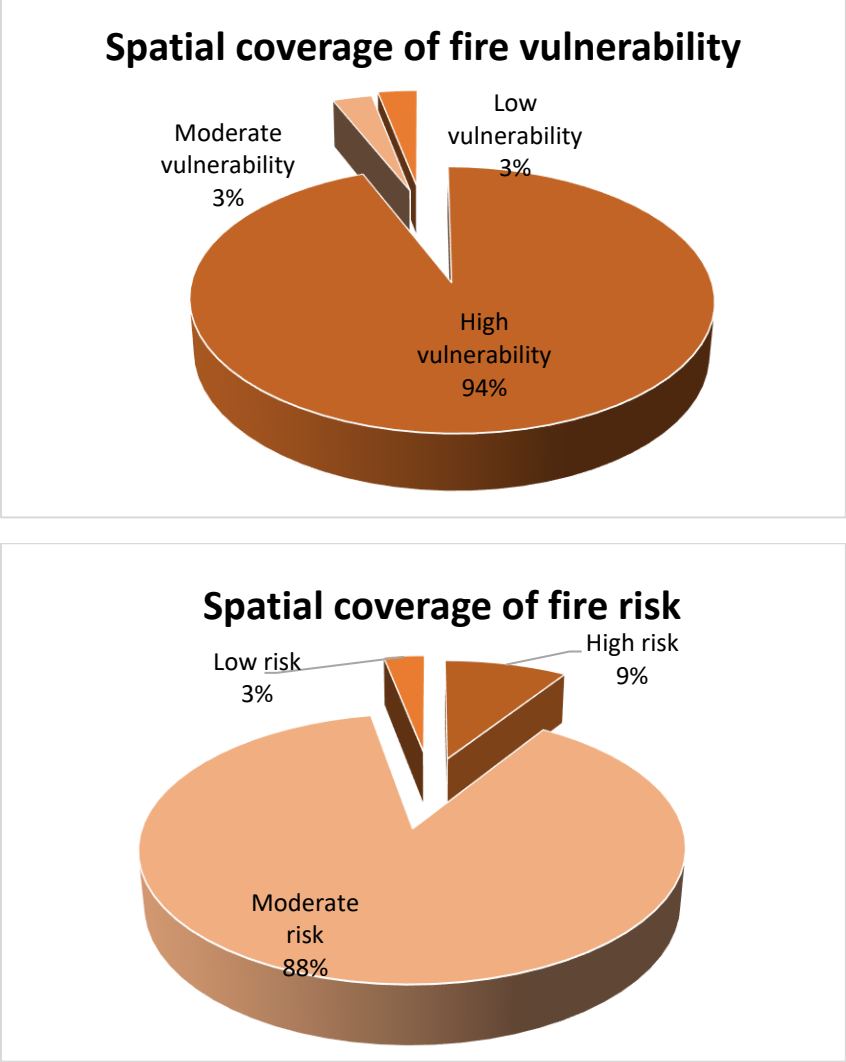


Figure 62. Spatial coverage of fire hazard (upper), vulnerability (middle), and risk (lower) classes

Qadisha:

Three maps were produced, namely, fire hazard, vulnerability and risk (**Figure 63**, **Figure 64**, and **Figure 65**). Percentages of spatial coverage of classified classes are provided in **Figure 66**. Observations from the classification results were as follows:

- Around 45% of the study area was classified as 'high hazard', while the remaining parts were classified as 'moderate to low hazard'. It is to be noted that the class 'high hazard' was mainly attributed to areas covered by thick and dense forest fuel.
- Around 57% of the total area of interest was classified as 'moderate to high vulnerability'. High vulnerability areas characterized mainly houses and infrastructures located close to dense forest fuel. In addition, the entire valley was mapped as 'high vulnerability' area due to its classification as UNESCO world heritage site. Simultaneously, 'moderate vulnerability' represented areas covered by relatively mature forested areas outside the valley.
- Around 53% of the total area was classified as 'high risk' and 38% as 'moderate risk'. High risk areas represented mainly the vegetated areas within the valley, in addition to highly combustible fuel in the Wildland-Urban Interface.

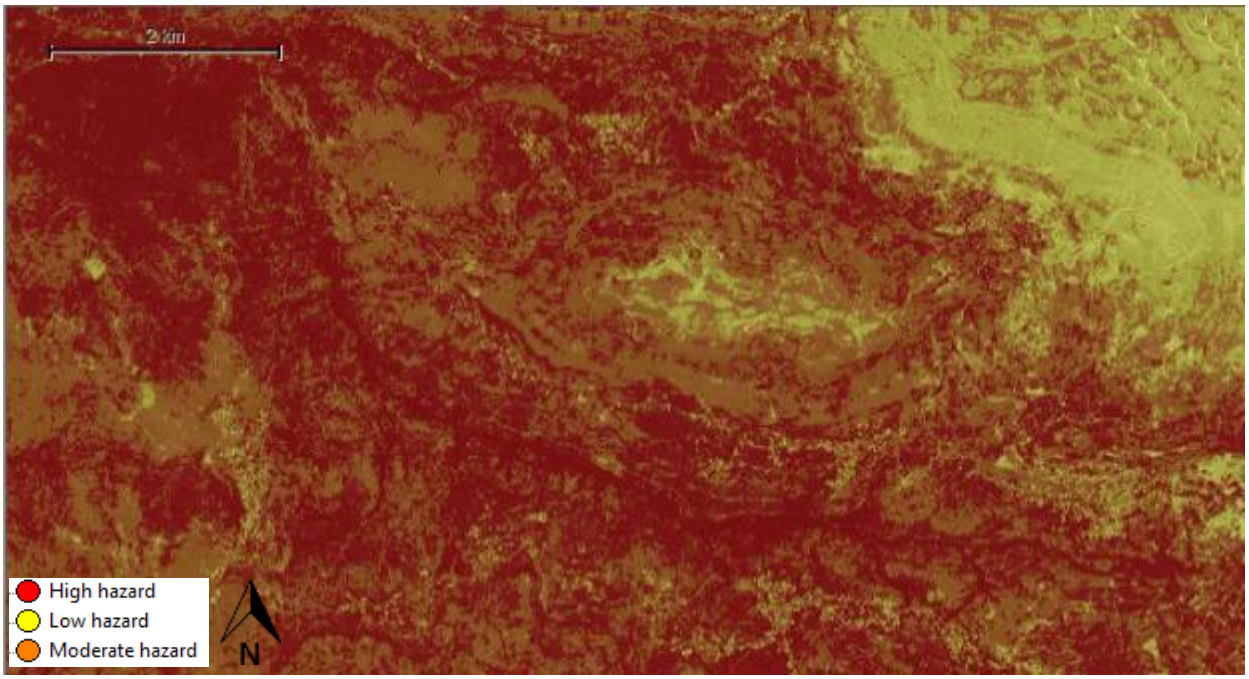


Figure 63. Fire hazard map of QV and its surrounding

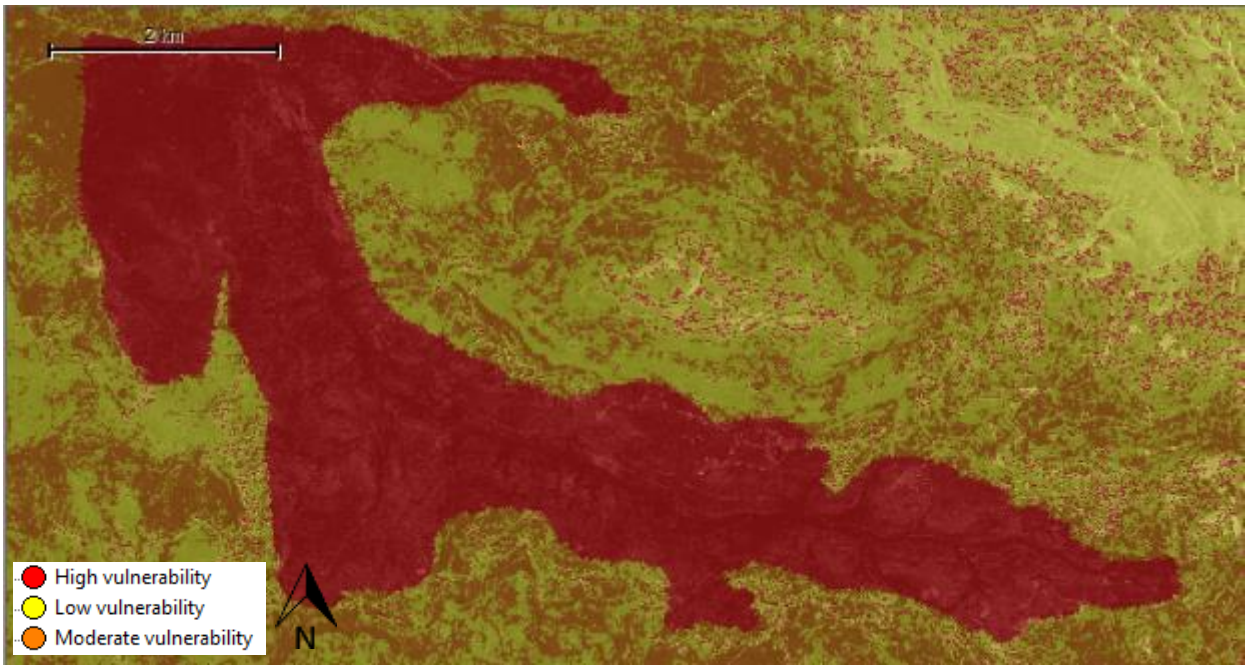


Figure 64. Fire vulnerability map of QV and its surrounding

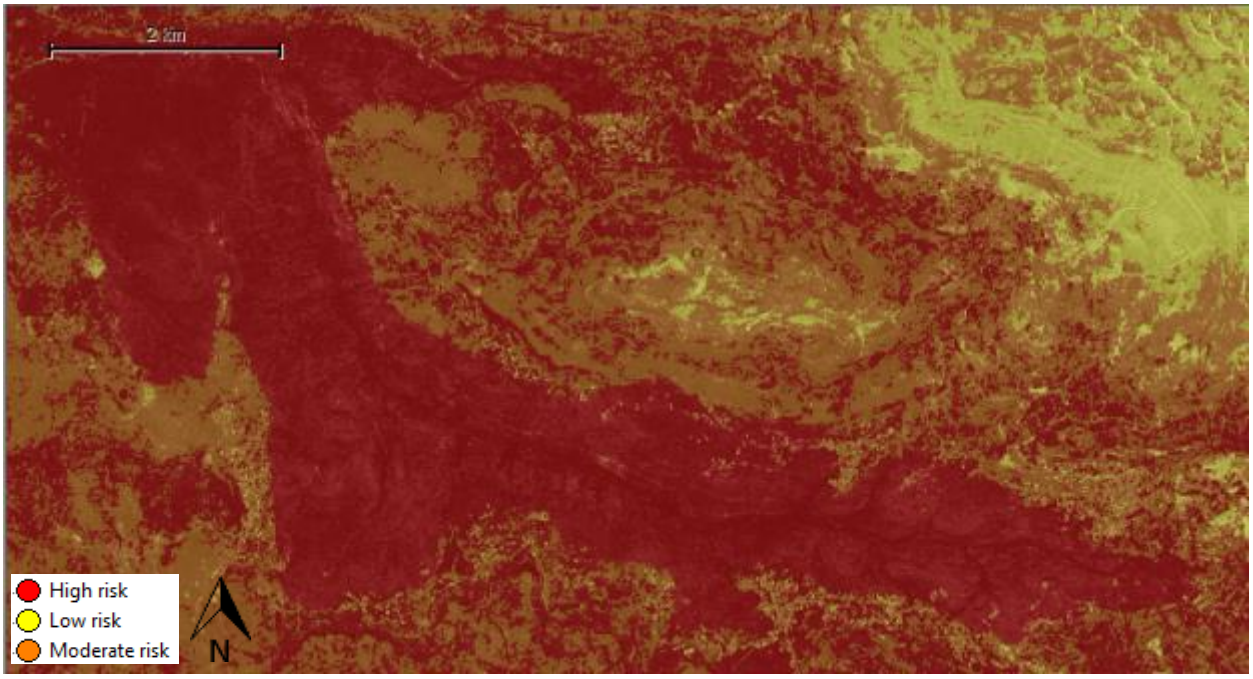
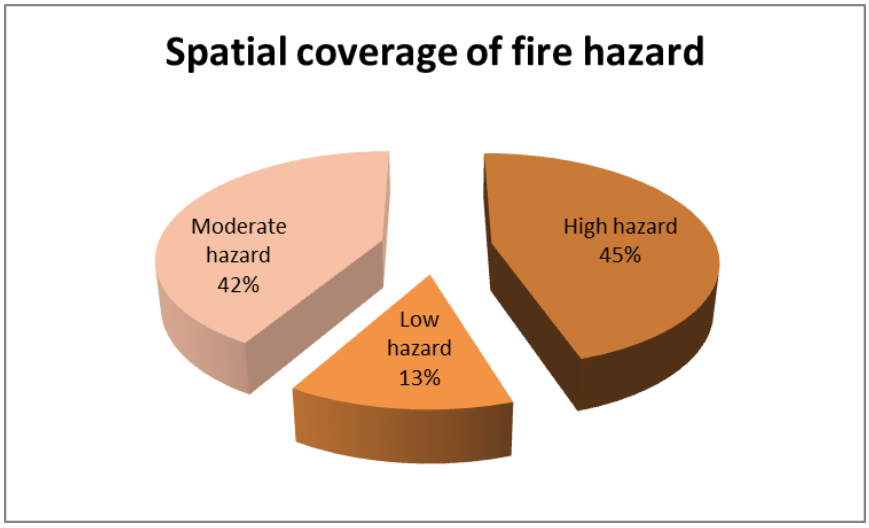
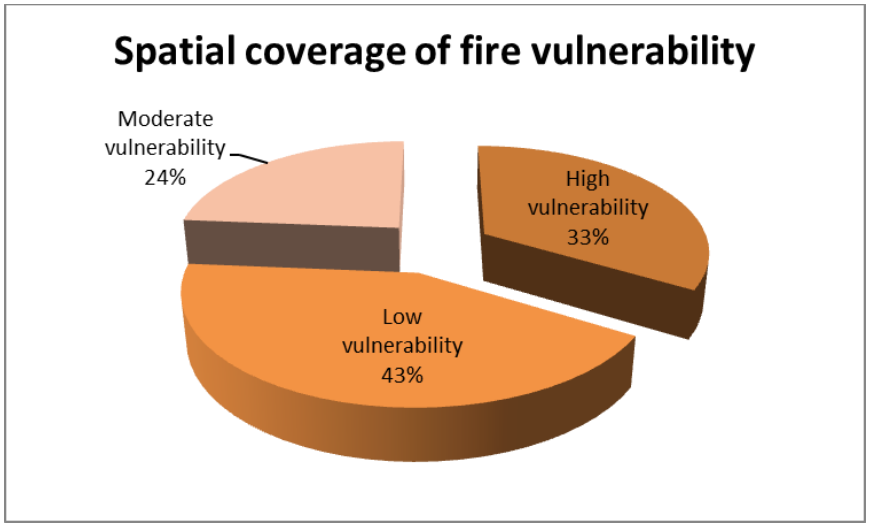


Figure 65. Fire risk map of QV and its surrounding





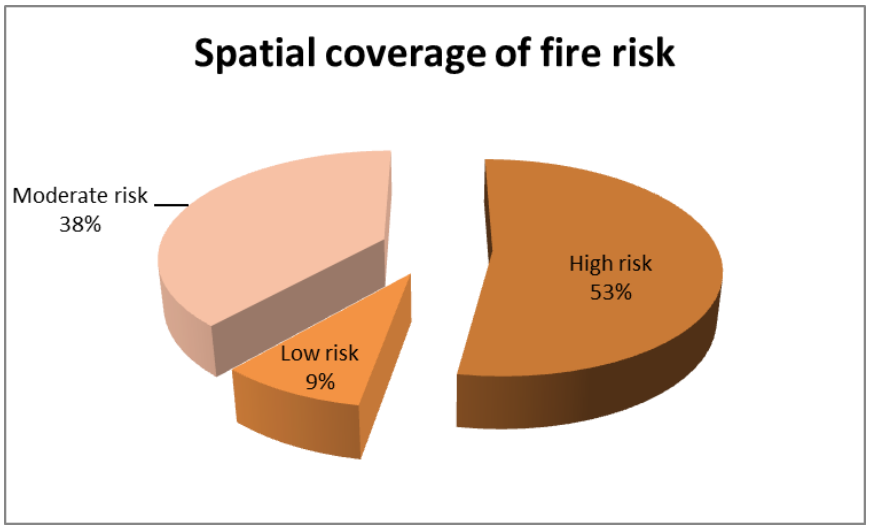


Figure 66. Spatial coverage of fire hazard (upper), vulnerability (middle), and risk (lower) classes

V. Applying Firewise

As described in the Firewise best practice guidelines (IOE-UOB/LRI, 2014), fuel combustibility and fire spreads are affected by many factors including:

- Fuel type (including spatial arrangement, density, size, etc.)
- Weather conditions (wind, temperature, etc.)
- Topography (slope, aspect, etc.)

The proposed Best Management Practices (BMPs) come within the framework of the second component of Lebanon's National Strategy for forest fire management (Decision No. 52/2009) which aimed at modifying fire risk by:

- Reducing fire hazards (particularly in dense forest areas)
- Implementing land, natural resource and community planning that incorporates management of wildland fire at all appropriate scales
- Developing a certain level of knowledge and public awareness and support towards forest fires.

1. Proposed action plans

Ajaltoun

Firewise Action Plan in Ajaltoun
Practical and technical prevention
Technically protecting Ajaltoun forests from fire risk
Starting works on scientific technical services to make forests more resistant to fire risk
Creating fire breaks and fuel breaks to prevent fire spread (in case of ignition)
Cleaning the existing waste in the forests and rehabilitating old waste disposal inside the forest

Developing a map that indicates water sources around and inside the forests (water wells - tanks nearby...) + providing tanks and installing a fire risk indicator sign
Readying a firefighting mechanism
Providing and training a firefighting center
Providing the center with firefighting manual tools offered to the municipality
Employing a forest guard during the fire season (3 months)
Planting activities by volunteers in the village
Installing awareness boards
Raising awareness of the residents of Ajaltoun and neighboring region about the importance of firefighting and educating them about the Firewise project
Creating a committee to follow up on fire prevention in Ajaltoun
Adding Firewise activities and information about the relevant forests on the social media page of the municipality
Organizing awareness campaigns (a play for children, meetings at schools...)
Training the volunteers in Ajaltoun for working in the firefighting center if created

Bentael

Firewise Action Plan in Bentael for 2015
Finding local solutions for safety by involving the local community in taking individual responsibility to protect the Bentael reserve from fire risk
Technically protecting Bentael reserve from fire risk
Starting works on scientific technical services to make the reserve more resistant to fire risk
Creating a unit to follow up on Firewise project and other projects related to protecting the site from fire risk
Creating fire breaks and fuel breaks to prevent fire spread (in case of ignition)
Cleaning roadsides in the reserve
Developing a map that indicates water sources around and inside the reserve
Reinforcing a water network ready to be used in case of a fire event
Installing a fire risk indicator sign
Planting suitable seedling species in specific places in the reserve
Creating a data bank
Equip human resources to help in implementing the activities of the project
Providing workers from the village to do the thinning and the planting
Involve the different categories of the local community (especially the youth and women) in pruning and planting activities
Raising awareness of the residents of Bentael and neighboring region about the importance of firefighting and educating them about the Firewise project
Setting the foundations necessary for the local community to organize similar initiatives to protect the region from fire risk in the future
Adding Firewise activities and information about the reforested site on the social media page of the reserve
Organizing awareness campaigns (a play for children, meetings at schools...)
Training a group of local residents on fire prevention and firefighting
Installing fire risk awareness signs
Raising awareness among the locals about the obligations of the citizens and the issued laws related to grazing and fire risk

Bkessine

Firewise Action Plan in Bkessine for 2015
Finding local solutions for safety by involving the local community in taking individual responsibility to protect the pine forest in Bkessine from fire risk
Technically protecting Bkessine region from fire risk
Starting works on scientific technical services to make the forest more resistant to fire risk
Creating a unit to follow up on the Firewise project
Creating fire breaks and fuel breaks to prevent fire spread (in case of ignition)
Cleaning roadsides in the Bkessine region
Developing a map that indicates water sources around and inside the forest
Planting suitable pine species seedlings in specific places in the forest
Installing a fire risk indicator sign on the local level to warn from fires
Adding Firewise activities and information about the reforested site on the social media page of the municipality
Equip human resources to help in implementing the activities of the project
Providing workers from the village to do the thinning and the planting
Involve the different categories of the local community (especially the youth and women) in pruning and planting activities
Raising awareness of the residents of Bkessine and neighboring region about the importance of firefighting and educating them about the Firewise project
Setting the foundations necessary for the local community to organize similar initiatives to protect the region from fire risk in the future
Organizing an awareness campaign to preserve the perennial trees
Training a group of local residents on fire prevention and firefighting
Raising awareness among the locals about the obligations of the citizens and the issued laws related to grazing and fire risk by the municipality
Installing fire risk awareness signs

Deir El Ahmar

Finding local solutions for safety by involving the local community in taking individual responsibility to protect the DA forests from fire risk
Protecting DA from fire risk
Starting works on scientific technical services to make forests more resistant to fire risk
Creating fire breaks and fuel breaks to prevent fire spread (in case of ignition)
Cleaning roadsides in the region from weeds
Creating a separation between agricultural and residential lands
Developing a map that indicates water sources around and inside the forests (water wells - tanks nearby - ponds...) in DA and the surrounding villages through a participatory session
Reinforcing a water network ready to be used in case of a fire event: Providing water intakes for firefighting trucks by creating 2 water tanks (130,000 liters, 4 m) for the civil defense
Installing 4 fire risk indicator signs to raise awareness about fire risk, displaying emergency phone numbers (civil defense), in particular in hunting areas and recreation sites

Organizing the coal production area: preparing a study about how to organize coal production in consultation with a technical expert
Providing motivation for volunteers in the civil defense by using, when needed, the tools provided to the municipality by the Firewise program
Raising awareness of the residents of DA about the importance of fire prevention and firefighting and educating them about the Firewise project
Creating a committee to follow up on fire prevention in DA, meeting whenever needed
Using the WhatsApp group of the municipality, the civil defense, the forest center and the security forces to warn of a fire event
Organizing meetings and awareness campaigns for the local community and the displaced Syrians (especially in schools) about fire prevention and firefighting
Training a group of young men and women from the region (from scout, associations and youth in DA) on fire prevention and firefighting

Hamat/Wajh El Hajar

Practical and technical prevention
Technically protecting Hamat and Wajh El Hajar forests from fire risk
Starting works on scientific technical services to make forests more resistant to fire risk
Creating fire breaks and fuel breaks to prevent fire spread (in case of ignition)
Cleaning the existing waste in the forests
Cleaning roadsides and removing weeds
Organizing a workshop about pruning techniques
Developing a map that indicates water sources around and inside the forests
Securing water sources and installing tanks around the forests
Providing a 4x4 firefighting truck
Providing the center with firefighting manual tools offered to the municipality
Planting activities by volunteers in the village
Installing awareness boards and a fire risk indicator sign
Creating a committee to follow up on fire prevention in Hamat and Wajh El Hajar
Adding Firewise activities and information about the relevant forests on the social media page
Organizing awareness campaigns for school students and youngsters (a play for children, meetings at schools...)
Organizing a training for volunteers in Hamat and Wajh El Hajar about firefighting techniques and the manual tools used
Creating a committee to follow up on fire prevention in Hamat and Wajh El Hajar
Adding Firewise activities and information about the relevant forests on the social media page
Organizing awareness campaigns for school students and youngsters (a play for children, meetings at schools...)
Organizing a training for volunteers in Hamat and Wajh El Hajar about firefighting techniques and the manual tools used

Jabal Moussa

Finding local solutions for safety by involving the local community in taking individual responsibility to protect the Jabal Moussa reserve from fire risk
Technically protecting Jabal Moussa reserve from fire risk
Equip human resources to help in implementing the activities of the project
Creating a unit to follow up on Firewise project and other projects related to protecting the site from fire risk
Providing workers from the village to do the thinning and the planting
Involve the different categories of the local community (especially the youth and women) in the activities of the project
Starting works on scientific technical services to make the reserve more resistant to fire risk
Cleaning roadsides in the reserve and the village of Yahchouch
Developing a map that indicates water sources around and inside the reserve
Reinforcing a water outlets network ready to be used in case of a fire event (benefitting from the existence of a river and a water network from Afqa)
Working on equipping a group to fight fires and equipping forest guards cabins at the entry of the reserve
Creating a data bank
Planting suitable seedling species in specific places in the reserve
Installing awareness raising boards in camping sites around the reserve
Preparing a specific vehicle to transport water to inaccessible places
Raising awareness of the residents of Yahchouch and neighboring region about the importance of firefighting and educating them about the Firewise project
Setting the foundations necessary for the local community to organize similar initiatives to protect the region from fire risk in the future
Adding Firewise activities on the social media pages of the reserve and the municipality
Organizing awareness campaigns about fire risks and the reasons for fire ignition
Training a group of local residents on fire prevention and firefighting in collaboration with the civil defense of the village

Menjez

Firewise Action Plan in Menjez for 2016
Finding local solutions for safety by involving the local community in taking individual responsibility to protect the Menjez forest from fire risk
Equip human resources in Menjez to implement the Firewise project
Creating a unit to follow up on Firewise project and designating a person in charge of implementing the project among the members of the Environmental Committee and the municipality of Menjez
Starting works on scientific technical services to make forests more resistant to fire risk
Providing a 4x4 firefighting truck
Cleaning roadsides
Creating fire breaks and fuel breaks to prevent fire spread (in case of ignition)
Equipping a center within the village with manual tools for first intervention in case of a fire event
Prepare a study to find an economically beneficial solution to get rid of the agricultural activities leftovers
Re-inaugurating the burnt lands in the reforestation site
Update and equip the civil defense center

Prepare a study about the creation of observation towers
Enhancing access to water sources
Organizing a participatory session to set a map indicating water sources around the forest
Studying a project to install a water line from the artificial lake to the road in order to enhance firefighting trucks access to water sources
Awareness
Installing a fire risk indicator sign on the local level and 4 boards to warn from fires
Adding Firewise activities and information about the reforested site on the social media page of the municipality
Organizing awareness sessions at schools about fire risk prevention
Organizing a training for a group of volunteers on first intervention in case of a fire event
Involve the different categories of the local community (especially the youth and women) in pruning and planting activities
General trainings about the foundations of firefighting

Qadisha

Finding local solutions for safety by involving the local community in taking individual responsibility to protect the QV from fire risk
Technically protecting QV lands from fire risk
Starting works on scientific technical services to make forests more resistant to fire risk
Creating fire breaks and fuel breaks to prevent fire spread (within the break Q3)
Cleaning roadsides at the entrance of the valley (from the entrance, through the work area, to the surroundings of the monastery Q5)
Creating safe buffer zones around picnic areas and camping sites (Q4)
Controlled and well managed pruning/trimming for charcoal production (within the scope of Q1 and Q2)
Installing fire risk indicator signs and a water sources map
Awareness boards (in all camping sites and strips of the valley, as well as the religious sites Q4)
Properly trimming vegetation near high voltage power lines to avoid any possible context with lines
Preparing a map with suitable lands for controlled grazing in QV
Providing a 4x4 firefighting truck for fast intervention
Communicating with the Ministry of Agriculture to create a center in charge of the forests within the scope of the valley
Equipping a center with manual tools for first intervention in case of a fire event
Training a group of local residents on fire prevention and firefighting (distributing the manual tools on risk areas)
Coordinating between the municipalities and local community and environmental associations and forest guards employed by Bcharreh Municipal Union
Organizing awareness campaigns at schools and using social media to increase awareness about fire risk prevention

2. Reducing fire hazard

BMPs need to be designed and implemented to manage existing forest fuel. In general, forest fuel management practices are planned forest management techniques used to increase the resilience of a forest and reduce the severity and spread of a fire in case of a wildfire event. A number of hand tools can be employed for applying local forest fuel management practices. Some of the main forest fuel management techniques that can be applied in these forests include:

- Pruning and thinning forest fuel
- Managing thinning debris and slash
- Weeding in reforested/afforested areas (Hamat & Menjez)

More specifically, forest fuel management often includes forest thinning to reduce surface, ladder, and crown fuels. By reducing tree density, a healthier forest stand is created in which trees experience less competition for sunlight, water, and nutrients and become more resilient to drought and insect attack. A fuel management treatment may also include pruning or removing the lower limbs of trees to reduce ladder fuel. However, care should be taken not to remove more than 50% of the live crown length of a tree. Undergrowth clearing involves the reduction and/or spatial (horizontal, vertical) separation of the lower vegetation layer. The presence of a single tree, isolated from the ground, without intermediate layers, avoids the fire spread from the surface to the crown layer and limits the fire intensity. Suppressed or sick trees and low branches can be eliminated by thinning and pruning (Ajaltoun & JM, Bkessine).

In the case of these forests, fuel management practices can be applied to strips of land along existing landscape features (e.g. road, rocky edges, etc.). When a fuel management activity is applied to a strip of land it is known as a fire break or fuel break. Some of the main forest fuel management techniques that can be applied include:

- Creating fire breaks (when possible) within moderate to high risk areas
- Creating fuel breaks within moderate to high risk areas

Fire break lines can consist of the creation of spatial discontinuity of fuel at the border of the dense forest and between the forest and agriculture or shrubland/grassland. When creating a fire break, all of the vegetation is removed down to bare soil, leaving almost nothing to burn. Fire breaks are a minimum of 1 meter wide (especially in grassland areas) and are used to control low-intensity fires. However, fire breaks are most of the time three times wider than the fuel height. This means that fire breaks can be quite wide, depending on the vegetation type.

Fuel breaks are strips of land in which fuel has been modified, but some trees and shrubs are retained. The objective is to reduce the amount of combustible material so that when a fire burns in the fuel break, it will decrease in intensity and consequently in spread. Areas treated in this matter are often referred to as shaded fuel breaks. In a shaded fuel break the trees are generally thinned so that their crowns no longer touch each other and are horizontally separated. Lower branches of overstory trees are pruned, reducing the ladder fuels. Shrubs and dead and down material are removed to reduce surface fuels. Not all small trees and shrubs need to be removed in a shaded fuel break, but the fuel reduction should create a horizontal space between small trees and nearby larger trees to minimize the transition of fire. Shaded fuel breaks are also most often placed along roads and around structures or linear landscape features. Fire breaks are often strategically placed along ridges, roads, and infrastructure.

Pruning residues should be treated properly. There are many options to treat pruning residues. These include shredding and compacting or shredding and composting. Alternatively, pruning residues can be collected on

specific sites (i.e., with not combustible fuel in the surrounding) and can be safely burned during the wet season (Ajaltoun & Qadisha).

Ajaltoun:

Overall, the following short-term intervention activities can be conducted within the very high-risk area: 1) creating a fire/fuel break along the existing new road/landscape features located in the very high-risk area and 2) treating fuel and avoiding uncontrolled waste disposal in specific areas for reducing fire hazards. These areas are mainly located in the Wildland-Urban Interface and on specific roads (i.e., the road leading to the Jeita river from the side of Ballouneh). A representation of proposed interventions is presented in **Figure 67** and **Figure *68***. All proposed interventions are listed **Table 8**.

Figure 67. Suggested fire breaks (red line), fuel breaks along existing landscape features (yellow lines), and fuel treatment (polygons) on the northern side of Ajaltoun

Figure 68. Suggested fire breaks (red line) and fuel treatment (polygons) on the southern side of Ajaltoun

Table 8. List of proposed interventions

ID	Type of intervention	Notes (widths of fuel and fire breaks depend on existing fuel situation on the ground)
A1	Fuel break	Length: 785 m along existing road– Control public access to Blata and display of fire warning signs
A2	Fire break	Length: 327 m to be further investigated, discussed and agreed on with the local community
A3	Fuel break	Length: 600 m along existing landscape feature
A4	Fuel treatment	Area: 37 ha – cleaning near roads
A5	Fuel break	Length: 850 m along existing landscape feature
A6	Fuel break	Length: 1235 m along existing landscape feature
A7	Fire break	Length: 1092 m to be further investigated, discussed and agreed on with the local community
A8	Fuel treatment and waste control	Area: 12 ha – Clear the area from existing waste disposal and burning of wastes – Display warning signs
A9	Fuel treatment	Area: 26 ha – Clean surface vegetation near roads
A10	General interventions to increase readiness and pre-suppression provisions	Refer to next section

Bentael:

The proposed fire break in Bentael is located on the western side of the Reserve mainly along the grassland area (**Figure 5**). The approximate total area of the fire break is around 700 m (2 m x 350 m). The main objective of clearing along these features (especially along the southern border of the Reserve) is to avoid the start of a fire. The proposed fuel breaks in Bentael are located on the southern side of the Reserve preferably along the border of the Reserve (**Figure 69**). The approximate total area of the fuel breaks is around 3000 m² (3 m x 1000 m).

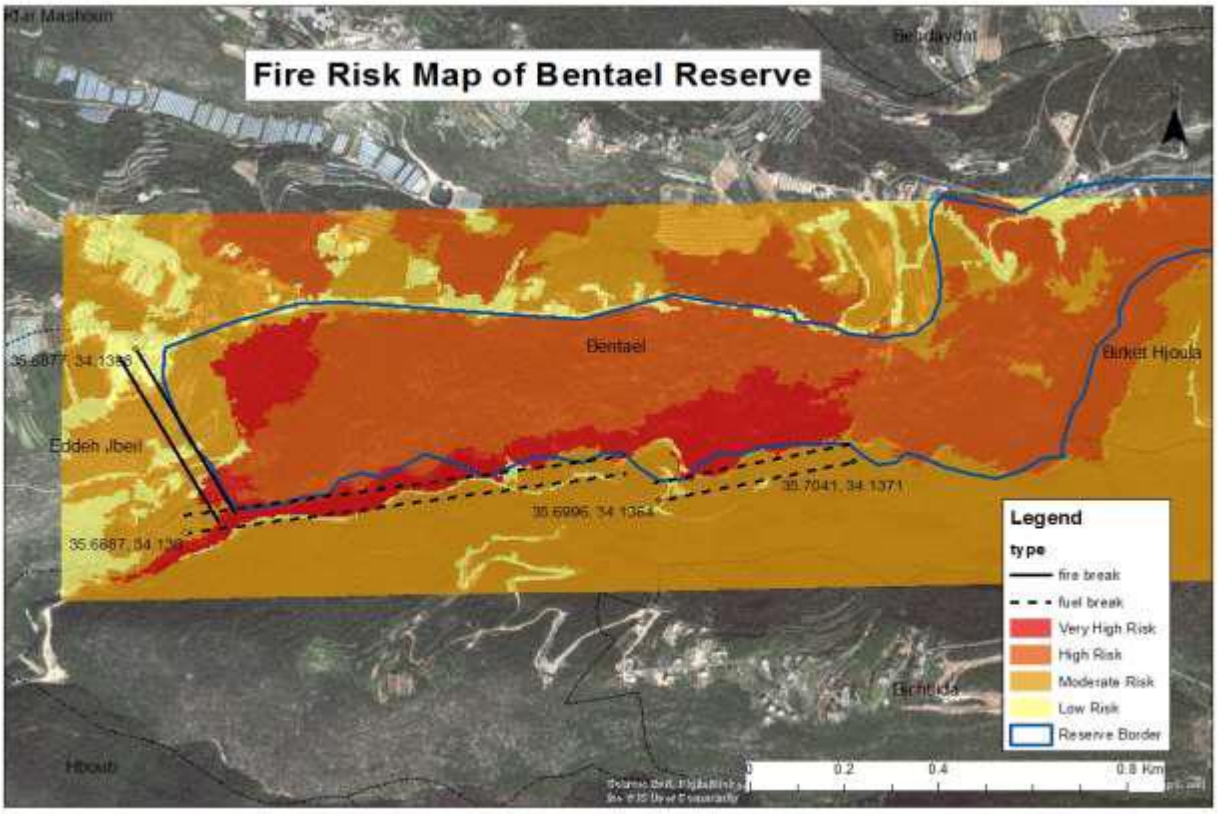


Figure 69. Proposed location of fire break (straight dark lines) and fuel breaks (dotted black lines)

Bkessine

It is critically important to note that 1) the current Forest Law in Lebanon generally forbids any conifer tree cutting, and 2) the surface fuel which results from thinning activities, known as slash, as well as surface fuel that existed prior to the thinning are to be removed as part of the fuel management.

Forest biomass management can generate a large amount of waste material (slash) that becomes a potential fuel for a fire. Accordingly, it is very important to manage this waste in such a way that it does not contribute to an increased fire hazard. In this context, the waste material can be modified in size and arrangement (e.g. shredding and compaction), burned (only for controlled burning during winter season and low risk periods), or removed from the site completely. One of the promising management techniques for managing thinning debris and slash is the production of biomass briquettes which involves drying, crushing, and compacting the material to serve as a fuel.

It is worth noting here that the Municipality of Bkessine is currently in the process of implementing a biomass project for collecting and shredding forest residues to produce briquette. The biomass project has started by conducting necessary studies and assessment by the Biodiversity Program at the Institute of the Environment, University of Balamand. The project is an ongoing initiative implemented in partnership with UNDP-CEDRO. The pruning or cutting should come in line with the forest management plan of the forest which is currently being prepared by the University of Balamand. Such a forest management plan includes a general and detailed forest inventories and a harvesting plan.

Overall, preserving a low-density vegetation cover to decrease fire spread is highly recommended for the study area of Bkessine. Frequent interventions must be done to maintain a low vegetation cover forest. In parallel, young *Pinus pinea* seedlings should be introduced to thinned areas and to low density forested areas to promote the growth of a young forest.

It is essential to recognize that any intervention for pruning, thinning, creating fire and fuel breaks for reduced fire risk should be in line with the Bkessine's forest management and harvesting plans.

Overall, the following short-term intervention activities can be conducted within the very high risk area (**Figure 70**): 1) creating a fire/fuel break along the existing road located in the very high risk area, and 2) plant young seedlings in the treated area for fire/fuel break and its surrounding with the purpose of maintaining a low density surface fuel to protect the young plantation and therefore reducing fire risk.
The estimated total area in the fire/fuel break is 3,000 m^2. In addition, the plantation of 1000 *Pinus pinea* seedlings can also promote the need to start a young pine forest.

Figure 70. Map for short-term intervention in Bkessine

Deir El Ahmar:

In general, it is very challenging to treat the fuel over the large extent of forested areas in DA. However, there is a need to address strategic location of fuel/fire breaks (e.g., cleared buffer zones or strips alongside existing roads in high fire risk areas) and to treat fuel within specific strategic areas (e.g., area of hunting, picnic and charcoal production). The following short-term intervention activities can be conducted within the very high-risk area: 1) creating a fire/fuel break along the existing new road/landscape features located in the very high-risk area, and 2) treating fuel and avoiding uncontrolled waste disposal, fireworks and campfires in specific areas for reducing fire hazards. A representation of proposed interventions is presented in **Figure 71**. All proposed interventions are listed **Table 8**.

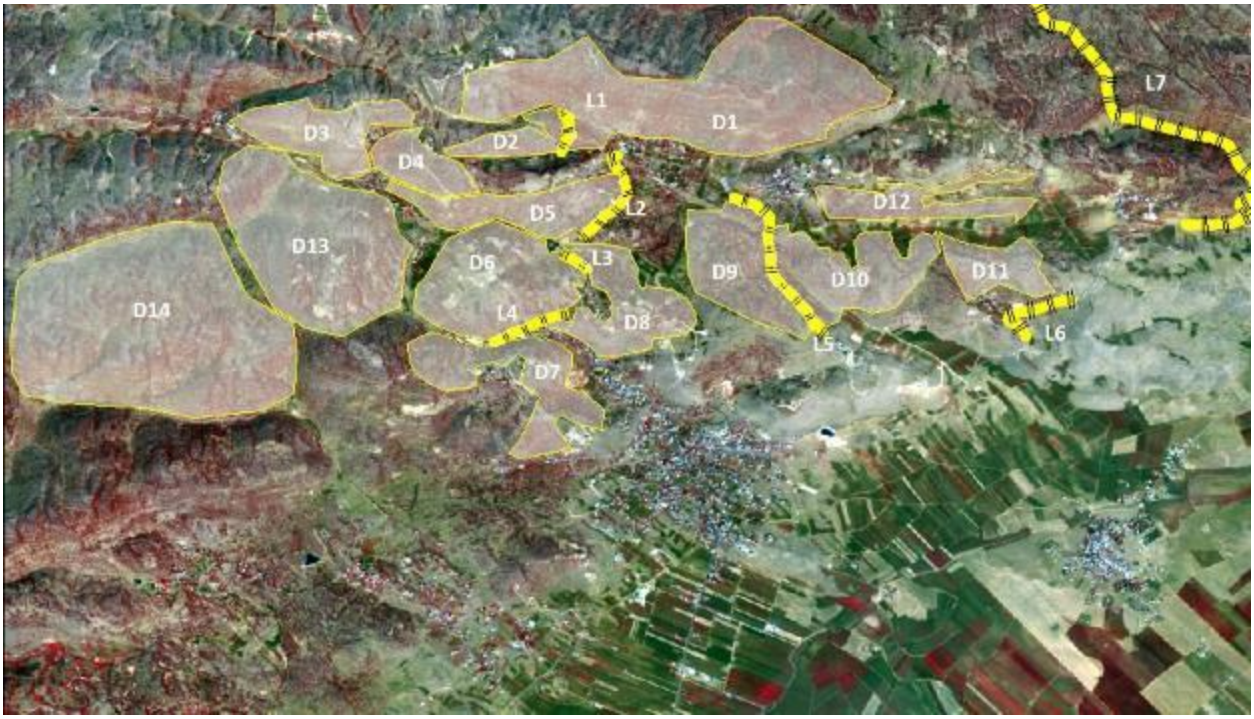


Figure 71. Suggested fire/fuel breaks (yellow lines), and fuel treatment (polygons)

Table 9. List of proposed interventions

ID	Type of intervention	Notes (widths of fuel and fire breaks depend on existing fuel situation on the ground)
D1	Fuel treatment	Area: 270 ha – Controlled grazing – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
D2	Fuel treatment	Area: 20 ha - Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.

D3	Fuel treatment	Area: 62 ha - Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
D4	Fuel treatment	Area: 29 ha - Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
D5	Fuel treatment	Area: 60 ha - Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
D6	Fuel treatment	Area: 103 ha – Forest Landscape Restoration of quarrying sites – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
D7	Fuel treatment	Area: 75 ha – Control charcoal production – Create safe buffer zones around settlements – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level –
D8	Fuel treatment	Area: 64 ha – Forest Landscape Restoration of quarrying sites – Create safe buffer zones around settlements – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level – Protect site from fireworks.
D9	Fuel treatment	Area: 67 ha – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level – create cleared buffer zones around picnic areas.
D10	Fuel treatment	Area: 74 ha – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level – Create cleared buffer zones around picnic areas.
D11	Fuel treatment	Area: 34 ha – Create safe buffer zones around settlements – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
D12	Fuel treatment	Area: 50 ha – Create safe buffer zone in the Agricultural – Wildland Interface – Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level - Protect site from fireworks – Create cleared buffer zones around picnic areas.
D13	Fuel treatment	Area: 186 ha – Control hunting area – Display fire warning signs – Proper disposal of wastes generated for scouts’

		activities – Place campfires on cleared sites – Forest landscape restoration of quarrying areas.
D14	Fuel treatment	Area: 341 ha – Control charcoal production – Controlled and well managed pruning/trimming of trees.
L1	Fire/fuel break	Length: 454 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road
L2	Fire/fuel break	Length: 1000 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road
L3	Fire/fuel break	Length: 300 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road
L4	Fire/fuel break	Length: 686 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road
L5	Fire/fuel break	Length: 1687 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road
L6	Fire/fuel break	Length: 885 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road
L7	Fire/fuel break	Length: 3840 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road
L8	General interventions to increase readiness and pre-suppression provisions	Refer to next section

More specifically, it is essential to treat vegetation nearby houses, picnic area, and monasteries/churches at risk of being affected by fire and to reduce the risk of fire propagation from these points.

Existing grazing in many parts of DA (e.g., mainly at higher elevation) makes the land covered by a low-density vegetation cover (**Figure 72Figure *72***). Controlled grazing is also suggested to reduce fuel accumulation on specific sites (e.g., abandoned agricultural land, near existing roads, etc.) within DA. In addition, charcoal production needs to be better managed and controlled. Some parts of the forests are pruned; however, pruning residues are left on the ground (**Figure 73**). This increases fire hazard in these areas. Accordingly, there are many options to treat pruning residues. These include shredding and compacting or shredding and composting.

Alternatively, pruning residues can be collected on specific sites (i.e., with not combustible fuel in the surrounding) and can be safely burned during the wet season.

Figure 72. Grazing exists in some parts of DA

Figure 73. Remaining of pruning residues in recently pruned forested areas

Hamat/Wajh El Hajar:

In general, it is very challenging to treat the fuel over the large extent of vegetated areas. However, there is a need to address strategic location of fuel/fire breaks (e.g., cleared buffer zones or strips alongside existing roads in high fire risk areas) and to treat fuel within specific strategic areas (e.g., area of hunting, picnic, and charcoal production). The following short-term intervention activities can be conducted within the very high-risk area: 1) creating a fire/fuel break along the existing new road/landscape features located in the very high-risk area, and 2) treating fuel (e.g., pruning, thinning, and weeding) and avoiding uncontrolled waste disposal, fireworks and campfires in specific areas for reducing fire hazards. A representation of proposed interventions is presented in **Figure 74**. All proposed interventions are listed in **Table 10** and in **Table 11**.

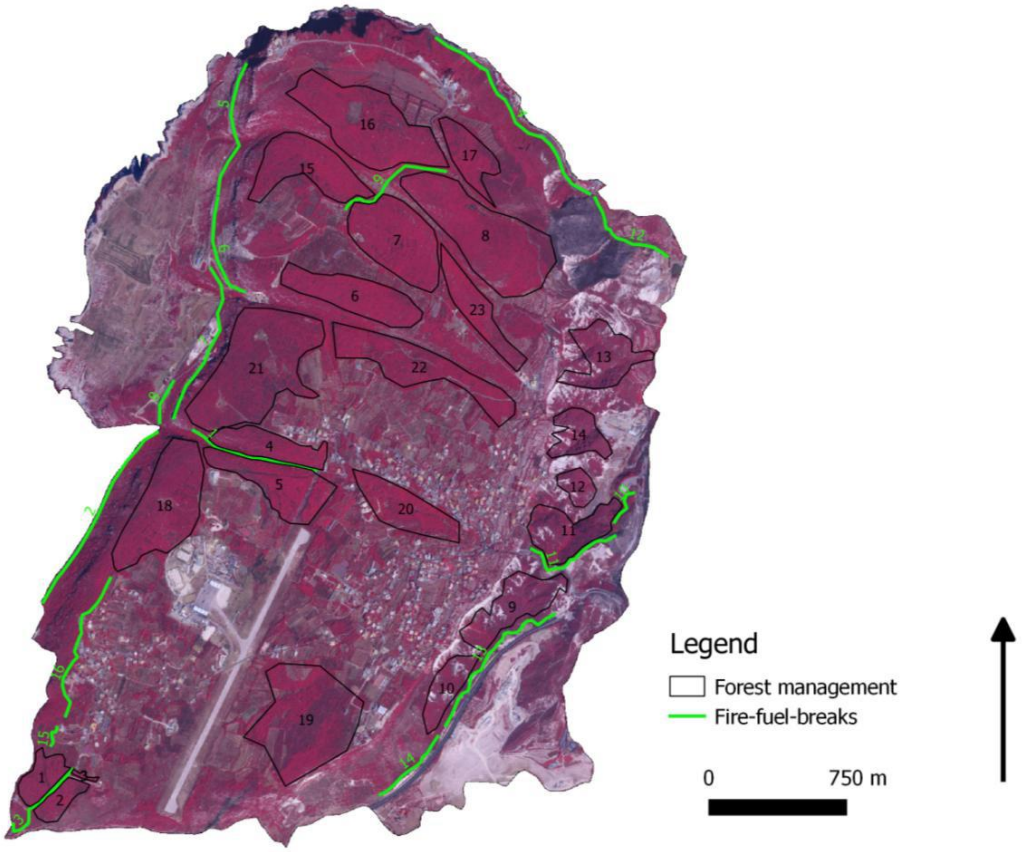


Figure 74. Suggested fire/fuel breaks (green lines) and fuel treatment (polygons)

Table 10. List of proposed interventions in fuel/fire breaks

Fire/fuel break id	**Type of intervention**	**Length (m)**	**Notes *(widths of fuel and fire breaks depend on existing fuel situation on the ground)***
1	Fire break	847	Cleaning of grass and trimming lower branches on both sides of the road to create a clean area as a fire break – Displaying fire warning signs along the road. Controlling picnic activities on both sides of the roads. Access to the forest and activities near forested areas should be controlled.
2	Fuel break	1218	Cleaning of grass and trimming lower branches on the eastern side of the road. Displaying fire warning signs along the road.
3	Fire break	592	Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road. Access to the forest and activities near forested areas should be controlled.
4	Fuel break	1379	Cleaning of grass and trimming lower branches on the south-western side of the road – Displaying fire warning signs along the road.
5	Fuel break	784	Cleaning of grass and trimming lower branches on eastern side of the road – Displaying fire warning signs along the road.
6	Fuel break	612	Cleaning of grass and trimming lower branches on eastern side of the road – Displaying fire warning signs along the road.
7	Fuel break	953	Cleaning of grass and trimming lower branches on eastern side of the road – Displaying fire warning signs along the road.
8	Fuel break	254	Cleaning of grass and trimming lower branches on eastern side of the road – Displaying fire warning signs along the road.
9	Fire break	766	Cleaning of grass and trimming lower branches on both sides of the existing road. Creating a continuous fire break between polygons 1 and 15.
10	Fire break	245	Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road. Controlling picnic activities on both sides of the roads. Access to the forest and activities near forested areas should be controlled.
11	Fire break	679	Creating a fire break by taking advantage of the existing landscape features. Controlling agricultural burning in the neighboring agricultural lands.
12	Fuel break	628	Cleaning of grass and trimming lower branches on the south-western side of the road – Displaying fire warning signs along the road. Protecting the neighboring fire affected areas from recurrent fires.

13	Fuel break	1054	Cleaning of grass and trimming lower branches on the western side of the highway – Access to the forest and activities near forested areas should be controlled. Any type of burning must be prohibited in this area.
14	Fuel break	509	Cleaning of grass and trimming lower branches on the western side of the highway – Access to the forest and activities near forested areas should be controlled. Any type of burning must be prohibited in this area.
15	Fire break	136	Creating a clean corridor around existing places for waste disposal. Controlling waste disposal in this area.
16	Fuel break	916	Cleaning of grass and trimming lower branches along the suggested line – Access to the forest and activities near forested areas should be controlled.

Table 11. List of proposed interventions in forest polygons

Plot id	**Type of intervention**	**Area (ha)**	**Notes**
1	Fuel treatment	5.6	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
2	Fuel treatment	4.1	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
3	Fuel treatment	0.4	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
4	Fuel treatment	9.7	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level – Control human recreational activities in this area.
5	Fuel treatment	15.5	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level – Control human recreational activities in this area.
6	Fuel treatment	15.4	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
7	Fuel treatment	20.7	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
8	Fuel treatment	32.1	Dense cover of oak trees/shrubs – Good practices of pruning/trimming are observed. Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level – Control human recreational activities in this area.
9	Fuel treatment	12.7	Dense mixed forest of oak and pine– Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.

10	Fuel treatment	7.0	Dense mixed forest of oak and pine– Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
11	Fuel treatment	11.9	Dense forest/shrubland – Controlled grazing in this area is recommended – Discontinue vertical fuel continuity from tree base level of existing trees.
12	Fuel treatment	3.6	Dense forest/shrubland – Controlled grazing in this area is recommended – Discontinue vertical fuel continuity from tree base level of existing trees.
13	Fuel treatment	11.8	Dense forest/shrubland – Controlled grazing in this area is recommended – Discontinue vertical fuel continuity from tree base level of existing trees.
14	Fuel treatment	7.3	Dense forest/shrubland – Controlled grazing in this area is recommended – Discontinue vertical fuel continuity from tree base level of existing trees.
15	Fuel treatment	16.6	Dense forest of oak trees – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level. Control agricultural activities in surrounding plots. Use of fire in agricultural practices must be prohibited.
16	Fuel treatment	28.6	Dense forest of oak trees – Good practices of pruning/trimming are observed. Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level. Control agricultural activities in surrounding plots. Use of fire in agricultural practices must be prohibited.
17	Fuel treatment	8.2	Dense forest of oak trees – Good practices of pruning/trimming are observed. Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level. Control agricultural activities in surrounding plots. Use of fire in agricultural practices must be prohibited.
18	Fuel treatment	24.0	Dense forest of oak trees. Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
19	Fuel treatment	32.0	Dense forest of oak trees. Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level. Protect recently burned areas from recurrent fires.
20	Fuel treatment	12.6	Dense forest of oak trees. Large wildland-Urban Interface. Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level. It is important to display fire warning signs.
21	Fuel treatment	35.7	Dense forest of oak trees. Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level
22	Fuel treatment	20.3	Dense forest of oak trees. Needs for well managed pruning/trimming activities of trees – Discontinue

			vertical fuel continuity from tree base level. Use of fire in agricultural practices within surrounding lands must be prohibited.
23	Fuel treatment	10.0	Dense cover of oak trees/shrubs – Needs for well managed pruning/trimming activities of trees – Discontinue vertical fuel continuity from tree base level.
-	Other activities: burned areas in the past 10 years need to be protected from recurring fires. General interventions to increase readiness and pre-suppression provisions	-	Refer to next section.

Furthermore, sources of fires must be prohibited along the circular road network (including highway, seaside road, etc.) around Hamat/Wajh el Hajar (**Figure 75**). Fires starting at these points can be disastrous to the vegetated slopes.

Figure 75. Source of fire on the seaside road below the vegetated slopes of Hamat on 7-11-2017

Also, it is essential to treat vegetation nearby houses, municipal facilities, agricultural lands, picnic areas, and monasteries/churches at risk of being affected of fire and to reduce the risk of fire propagation from/to these

points. Controlled grazing is also suggested in the dense oak forest to reduce fuel accumulation on specific sites, while recently burned areas must be protected from any grazing activity and from other disturbances (e.g., recurrent fires, human activities). There are many options to treat pruning residues. These include shredding and compacting or shredding and composting. Alternatively, pruning residues can be collected on specific sites away from fire hazard areas and can be safely burned during the wet season. Alternatively, pruning residues can be shredded and compacted for briquette production. It is worth noting that one briquetting plant is currently being established in the Koura region.

Jabal Moussa:

Overall, the following short-term intervention activities can be conducted within moderate to very high-risk area: 1) creating a fire/fuel break along the existing new road/landscape features located in the very high-risk area, and 2) treating fuel and avoiding uncontrolled waste disposal in specific areas for reducing fire hazards. These areas are mainly located in the wildland-urban interface and on specific roads (i.e., the road to Chouan which is very frequently accessed by visitors). A representation of proposed interventions is presented in **Figure 76** and **Figure 77**. All proposed interventions are listed in **Table 12**.

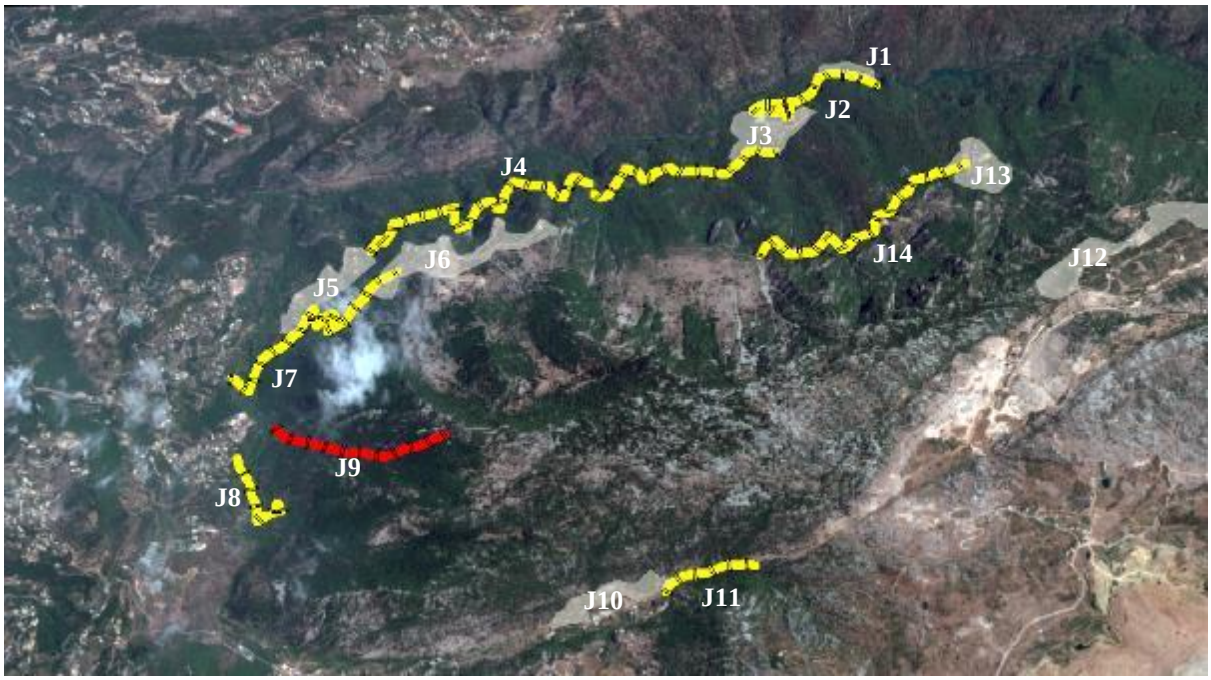


Figure 76. Overview of suggested fire breaks (red line), fuel breaks (yellow lines) and fuel treatment (polygons) in JM

Figure 77. Subsets of suggested intervention

Table 12. List of proposed interventions

ID	Type of intervention	Notes (widths of fuel and fire breaks depend on existing fuel situation on the ground)
J1	Fuel treatment	Area: 1.75 ha – Cleaning of ground vegetation around picnic and cafes areas – Managing waste disposal sites for reducing possible fire occurrence and spread to vegetated lands.
J2	Fuel break	Length: 1074 m – Cleaning on both sides of the road to reduce the risk of fire spread – Displaying fire warning signs along the road - Managing waste disposal sites for reducing possible fire occurrence and spread to vegetated lands.
J3	Fuel treatment	Area: 8.5 ha – Creating safe buffer zones around settlements, picnic areas and camping sites – Displaying fire warning signs on visitors sites – Managing waste disposal sites for reducing possible fire occurrence and spread to vegetated lands.
J4	Fuel break	Length: 1223 m – Cleaning on both sides of the road to reduce the risk of fire spread – Displaying fire warning signs along the road – Removing vegetation in contact or close to power lines – Managing waste disposal sites for reducing possible fire occurrence and spread to vegetated lands.
J5	Fuel treatment	Area: 9.2 ha – Creating safe buffer zones around settlements and agricultural lands – Displaying fire warning signs on visitors sites
J6	Fuel treatment	Area: 15.7 ha – Creating safe buffer zones around settlements and agricultural lands – Displaying fire warning signs on visitors sites
J7	Fuel break	Length: 1691 m – Cleaning on both sides of the road to reduce the risk of fire spread – Displaying fire warning signs along the road
J8	Fuel break	Length: 637 m – Cleaning on both sides of the road to reduce the risk of fire spread – Displaying fire warning signs along the road
J9	Fire break	Length: 990 m – Clearing fuel along existing landscape ridge to create a fire break – the establishment of the fire break is to be further investigated, discussed and agreed on with the local community
J10	Fuel treatment	Area: 8.24 ha – Creating safe buffer zones around settlements and agricultural lands– Displaying fire warning signs on visitors sites
J11	Fuel break	Length: 543 m – Cleaning on both sides of the road to reduce the risk of fire spread – Displaying fire warning signs along the road
J12	Fuel treatment	Area: 17 ha – Creating safe buffer zones around settlements and agricultural lands– Displaying fire warning signs on visitors sites

J13	Fuel treatment	Area: 8 ha – Creating safe buffer zones around settlements and agricultural lands– Displaying fire warning signs on visitors sites – Charcoal production in this area and other areas throughout JM should be carefully monitored and controlled
J14	Fuel break	Length: 1553 m – Cleaning on both sides of the road to reduce the risk of fire spread – Displaying fire warning signs along the road
J15	General interventions to increase readiness and pre-suppression provisions	Refer to next section

More specifically, it is essential to treat vegetation nearby houses, picnic area, and monasteries/churches at risk of being affected of fire and to reduce the risk of fire propagation from/to these points.

Controlled grazing is also suggested to reduce fuel accumulation on specific sites (e.g., abandoned agricultural land, near existing roads, etc.). However, charcoal production needs to be well managed and controlled. As for pruning residues, there are many options to treat these residues. These include shredding and compacting or shredding and composting. Alternatively, pruning residues can be collected on specific sites (i.e., with not combustible fuel in the surrounding) and can be safely burned during the wet season.

Menjez:

In general, it is very challenging to treat the fuel over the large extent of vegetated areas. However, there is a need to address strategic location of fuel/fire breaks (e.g., cleared buffer zones or strips alongside existing roads in high fire risk areas), and to treat fuel within specific strategic areas (e.g., area of hunting, picnic, and charcoal production). The following short-term intervention activities can be conducted within the very high-risk area: 1) creating a fire/fuel break along the existing new road/landscape features located in the very high-risk area, and 2) treating fuel (i.e. weeding) and avoiding uncontrolled waste disposal, fireworks, and campfires in specific areas for reducing fire hazards. A representation of proposed interventions is presented in **Figure 78**. All proposed interventions are listed in **Table 13**.

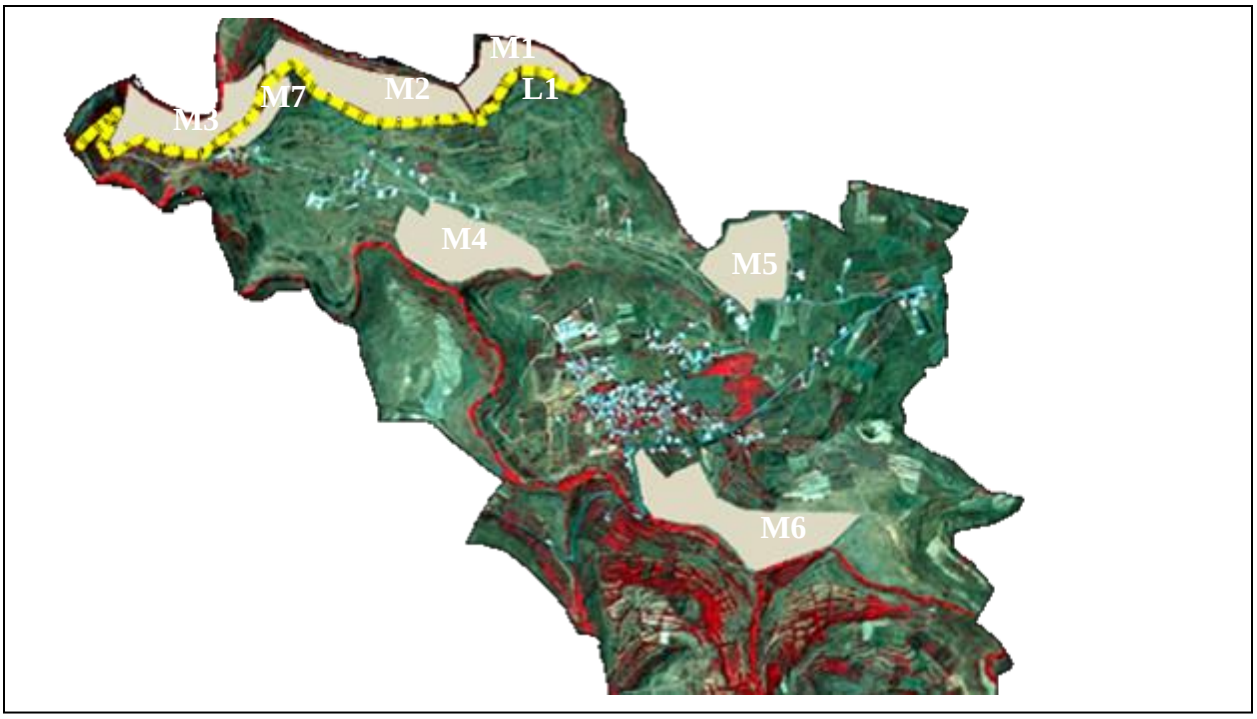


Figure 78. Suggested fire break (red), fuel breaks (yellow lines) and fuel treatment (polygons)

Table 13. List of proposed interventions

ID	**Type of intervention**	**Notes *(widths of fuel and fire breaks depend on existing fuel situation on the ground)***
L1	Fire/fuel break	Length: 2000 m – Cleaning of grass and trimming lower branches on both sides of the road – Displaying fire warning signs along the road. The line is to be managed taking into account the recently established road on the border of the forest. Access to the forest and activities near forested areas should be controlled.
M1	Fuel treatment	Approximate area: 7 ha – Dense forest - Controlled grazing Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
M2	Fuel treatment	Approximate area: 14 ha – Dense forest – Controlled grazing - Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
M3	Fuel treatment	Approximate area: 10 ha – Dense forest – Controlled grazing - Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level.
M4	Fuel treatment	Approximate area: 9 ha – Land comprises planted forest tree seedlings and grass. Create fire breaks on the border of the plot by the grass and benefiting from exiting landscape

		features (e.g. roads), in addition to weeding in patches of dense grass coverage. Displaying fire warning signs.
M5	Fuel treatment	Approximate area: 3 ha – Land comprises planted forest tree seedlings and grass. Create fire breaks on the border of the plot by the grass and benefiting from exiting landscape features (e.g. roads), in addition to weeding in patches of dense grass coverage. Display fire warning signs.
M6	Fuel treatment	Approximate area: 3 ha – Land comprises planted forest tree seedlings and grass. Create fire breaks on the border of the plot by the grass and benefiting from exiting landscape features (e.g. roads), in addition to weeding in patches of dense grass coverage. Display fire warning signs.
M7	Fuel treatment	Dense forest - Controlled grazing Controlled and well managed pruning/trimming of trees – Discontinue vertical fuel continuity from tree base level. – Display fire warning signs especially on the road towards the monastery.
Other activities	General interventions to increase readiness and pre-suppression provisions	Refer to next section.

More specifically, it is essential to treat vegetation nearby houses, picnic area, and monasteries/churches at risk of being affected of fire and to reduce the risk of fire propagation from these points. Controlled grazing is also suggested in the dense oak/laurel forest to reduce fuel accumulation on specific sites, while recently planted sites must be protected from any grazing activity. There are many options to treat pruning residues. These include shredding and compacting or shredding and composting. Alternatively, pruning residues can be collected on specific sites (i.e., with not combustible fuel in the surrounding) and can be safely burned during the wet season. Also, leaves from laurel trees extracted from pruning residues can be used in the production of essential oil from laurel (a production under development in Menjez).

Qadisha:

In general, it is very challenging to treat the fuel all over QV, however, there is a need to address strategic location of fuel/fire breaks (e.g., cleared buffer zones or strips alongside the main access road in the valley). The following short-term intervention activities can be conducted within the very high-risk area: 1) creating a fire/fuel break along the existing new road/landscape features located in the very high-risk area, and 2) treating fuel and avoiding uncontrolled waste disposal in specific areas for reducing fire hazards. A representation of proposed interventions is presented in **Figure 79**. All proposed interventions are listed in **Table 14**.

Figure 79. Suggested fire/fuel breaks (yellow lines) and fuel treatment (polygons)

Table 14. List of proposed interventions

ID	**Type of intervention**	**Notes** ***(widths of fuel and fire breaks depend on existing fuel situation on the ground)***
Q1	Fuel treatment	Area: 360 ha – Controlled and well managed pruning/trimming for charcoal production
Q2	Fuel treatment	Area: 228 ha – Controlled and well managed pruning/trimming for charcoal production
Q3	Fire/fuel break	Length: 3073 m – Cleaning on both sides of the road to reduce the risk of fire spread – Displaying fire warning signs along the road
Q4	Fuel treatment and clearing of herbaceous vegetation	Area: 34 ha – Creating safe buffer zones around picnic areas and camping sites – displaying fire warning signs on visitors sites
Q5	Fuel treatment and clearing of herbaceous vegetation	Area: 49 ha – Careful monitoring of tourists activities, cleaning herbaceous vegetation along road sides, and safe disposal of agricultural wastes.
Q6	General interventions to increase readiness and pre-suppression provisions	Refer to next section

More specifically, it is essential to treat vegetation nearby houses, restaurants, and monasteries at risk of being affected of fire and to reduce the risk of fire propagation from these points.

Grazing (**Figure 80**) exists in some parts of QV (e.g., Fradiss). Controlled grazing is also suggested to reduce fuel accumulation on specific sites (e.g., abandoned agricultural land, near existing roads, etc.) within QV. In addition, charcoal production in forested areas on the lower part of QV (mainly in Q1 and Q2) needs to be better managed and controlled. Also, vegetation near high voltage power lines should be properly trimmed to avoid any possible context with lines; however, the risk of fire from possible damage to the power lines or tower is always there. This should be taken into account in future monitoring and control of fire occurrence.

Figure 80. Grazing exists in some parts of QV

3. Increasing readiness and pre-suppression provisions

As per Lebanon's national strategy for forest fire management, there is a need to conduct a proper distribution at the landscape level of fire-fighting infrastructures and conduct an inventory of current fire-fighting resources which are available and desired future resources (aerial and ground infrastructure) such as fire lookout towers, water reservoirs and outlets near high fire risk areas, forest tracks and road network in general, forest strips with low tree density and low shrub cover, fire break areas of first and second level, forest tracks with fire break lines along them, protection perimeters in urbanized areas and firefighting units.

4. Managing exiting waste disposal sites and waste burning

Ajaltoun:

First, it is essential to carefully manage existing waste disposal (**Figure 81**) and waste burning points (**Figure 82**) which are present on different sites close to forested areas. More specifically, the presence of several waste disposal sites (a minimum of 10 sites) poses a threat to fire occurrence and spread to neighboring vegetated areas. Ideally, it is essential to close all existing waste disposal sites and forbids waste burning to reduce fire risk in these areas.

Figure 81. Waste disposal close to a forested area on the southern side of Ajaltoun

Figure 82. Burning agricultural and other wastes on a site close to vegetated areas

Jabal Moussa:

The presence of several waste disposal sites (a minimum of 10 sites) poses a threat to fire occurrence and spread to neighboring vegetated areas. Accordingly, it is essential to close all existing waste disposal sites and forbids waste burning to reduce fire risk in these areas.

In this context, it is essential to carefully manage and control existing waste disposal (**Figure 83**) and waste burning points (**Figure 84**) which are present on different sites close to forested areas especially those that are located close to highly combustible vegetation. For instance, Chouan does not dispose a system for waste collection. As such, wastes generated by visitors are frequently burned on site.

Figure 83. Waste burning in Chouan

Figure 84. Burning wastes close to highly combustible fuel

Also, waste disposal points along the road to Chouan (**Figure 85**) should be cleaned and warning signs from throwing garbage on these sites should be displayed.

Figure 85. Uncontrolled waste disposal along the road to Chouan

5. Managing exiting picnic areas and camping sites

Qadisha:

It is essential to carefully manage existing picnic and camping areas (**Figure 86**) which are present on different sites within forested areas (e.g., in Q4 area of Figure 79) mainly by 1) clearing vegetation around these sites, 2) disposing properly wastes, and 3) restricting campfires to specific sites only.

Figure 86. An example of a camping/picnic site in QV

6. Provisions of information

It would be important to map and display water sources and accessibility across the forest. Accordingly, water outlets should be clearly shown on relevant maps including the road and trail networks for use by firefighters in case of a fire event. Recently, Menjez placed water tanks for a total capacity of 80,000 liters. These can also serve in firefighting activities. The Bentael Nature Reserve has already established a number of water outlets across the Reserve (**Figure 87**). A number of water outlets across the Bkessine forest have already been established, too. Water outlets, however, should be properly placed and controlled in Hamat and Menjez.

Figure 87. Water outlets in Bentael Nature Reserve

7. Fire weather index

Bentael

Currently, there is a plan to deploy an Automated Weather Station in Bentael Nature Reserve within the framework of the STREG project at the Ministry of Environment. Accordingly, it would be essential to take advantage of the deployed weather station for generating a daily fire weather index for the area.
This is supposed to provide warning about days of high risk of fires.

Bkessine

Currently, there is a plan to deploy an Automated Weather Station in Bkessine within the framework of the EU funded Support to Reforms – Environmental Governance (STREG) project at the Ministry of Environment. Accordingly, it would be essential to take advantage of the deployed weather station for generating a daily fire weather index for the area. This is supposed to provide warning about days of high risk of fires.

8. Public awareness

It is also recommended to display warning signs about the risk of fires (**Figure 88**). Warning signs are mounted and displayed in areas easily accessible by visitors and hikers among others. It is also recommended to display signs along the new road to the south of the Reserve in Bentael.

Figure 88. Examples of warning signs produced within the "Firewise-Lebanon" project

9. Best practice guidelines and community engagement

Best practice guidelines for 1) managing fire risk in Lebanon's abandoned agricultural lands, 2) managing fire risk in Lebanon's dense forests, and 3) engaging communities in developing plans for wildfire risk management activities were produced and published by IOE-UOE/LRI (2014) in both Arabic and English (**Figure 89**). It is recommended that community groups in these villages and their surrounding refer to such guidelines for future activities in relation to fire risk management.

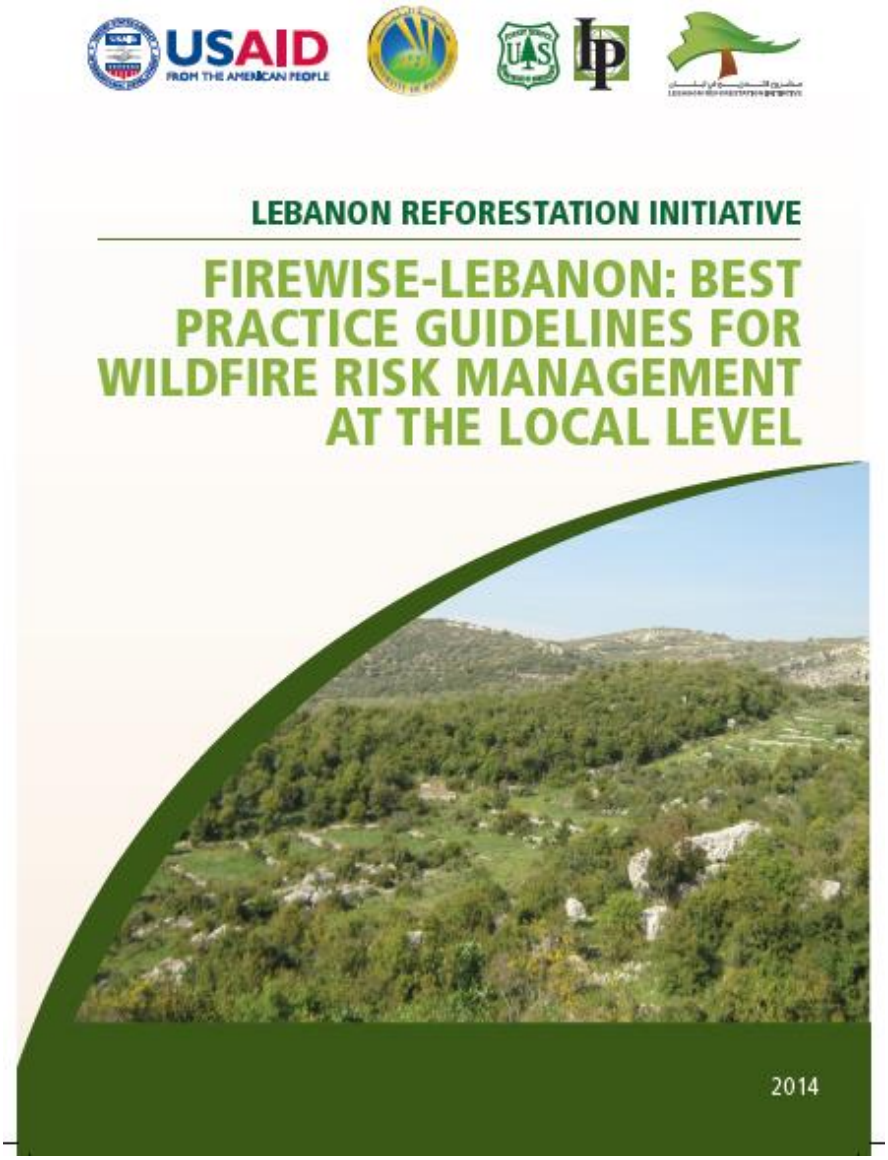


Figure 89. Firewise best practice guidelines for wildfire risk management

VI. References

GFMC, 2010. Forest fire threat in Qadisha valley, Lebanon: precautionary action to prevent damage or destruction of the UNESCO world heritage site. Report of an initial project (Qadisha).

IOE-UOB/LRI, 2014. Firewise-Lebanon: best practice guidelines for wildfire risk management at the local level. A publication of the Institute of the Environment, University of Balamand, and Lebanon Reforestation Initiative, Lebanon.