Fire risk Assessment of Jabal Moussa (Kesrouan-Jbeil) and its surrounding

(Brief assessment report)

Prepared as part of the project Firewise-Lebanon conducted by Lebanon Reforestation Imitative (LRI)

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1. Introduction

This works aims at providing a spatial assessment of fire risk in the Biosphere Reserve (BR) of Jabal Moussa (JM) and its surrounding 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.
- Develop a list of recommendations in line with the best practice guidelines of Firewise-Lebanon and based on the expert knowledge and the landscape specific characteristics.

2. Study area and dataset description

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 ed 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 1). The BR is located 50 km away from the capital Beirut.

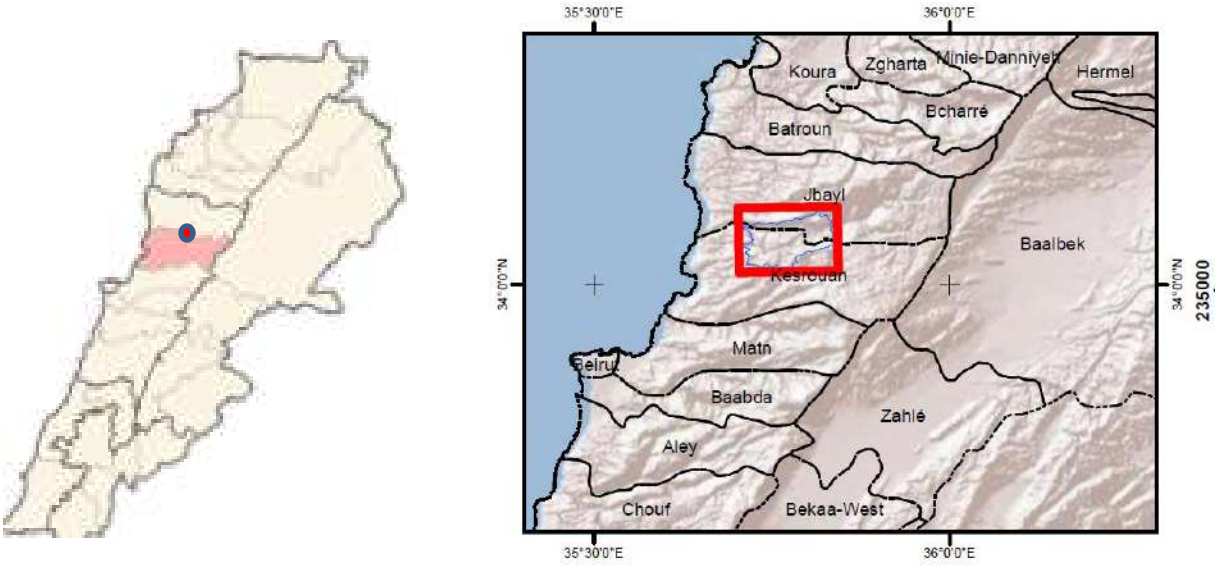

Figure 1. Location of Jabal Moussa BR Kesrouan-Jbeil (left) and its delineation (right)

The BR covers an area of 6500 ha at an altitude ranging between 350m and 1700m. 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 2). The main in the

transitional zone include forest management, charcoal production, traditional agricultural activities, fruit trees plantation, and grazing among others.

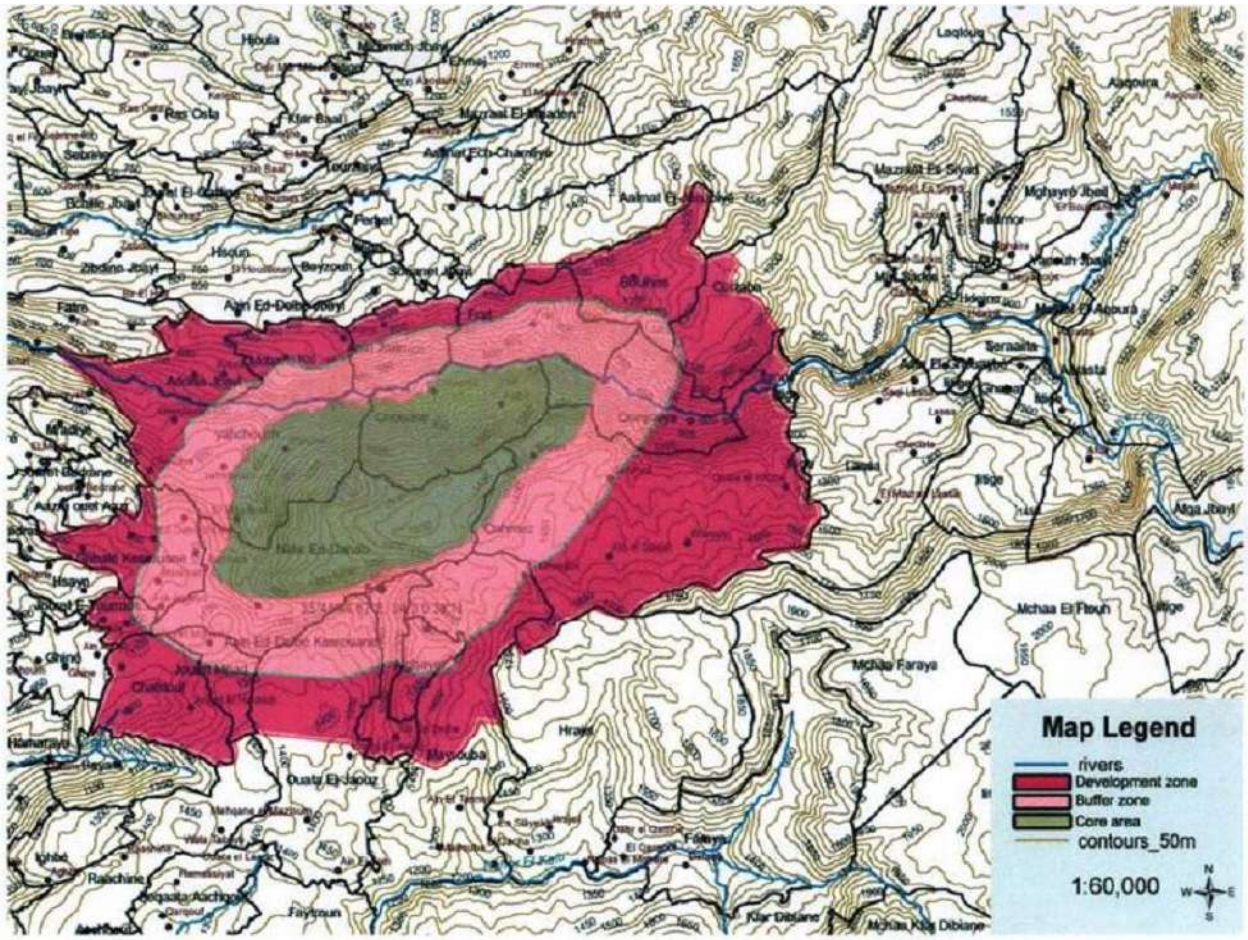

Figure 2. Zonation of the BR (source: Association for the Protection of Jabal Moussa)

The phyto-ecological map of JM (Figure 3) 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.

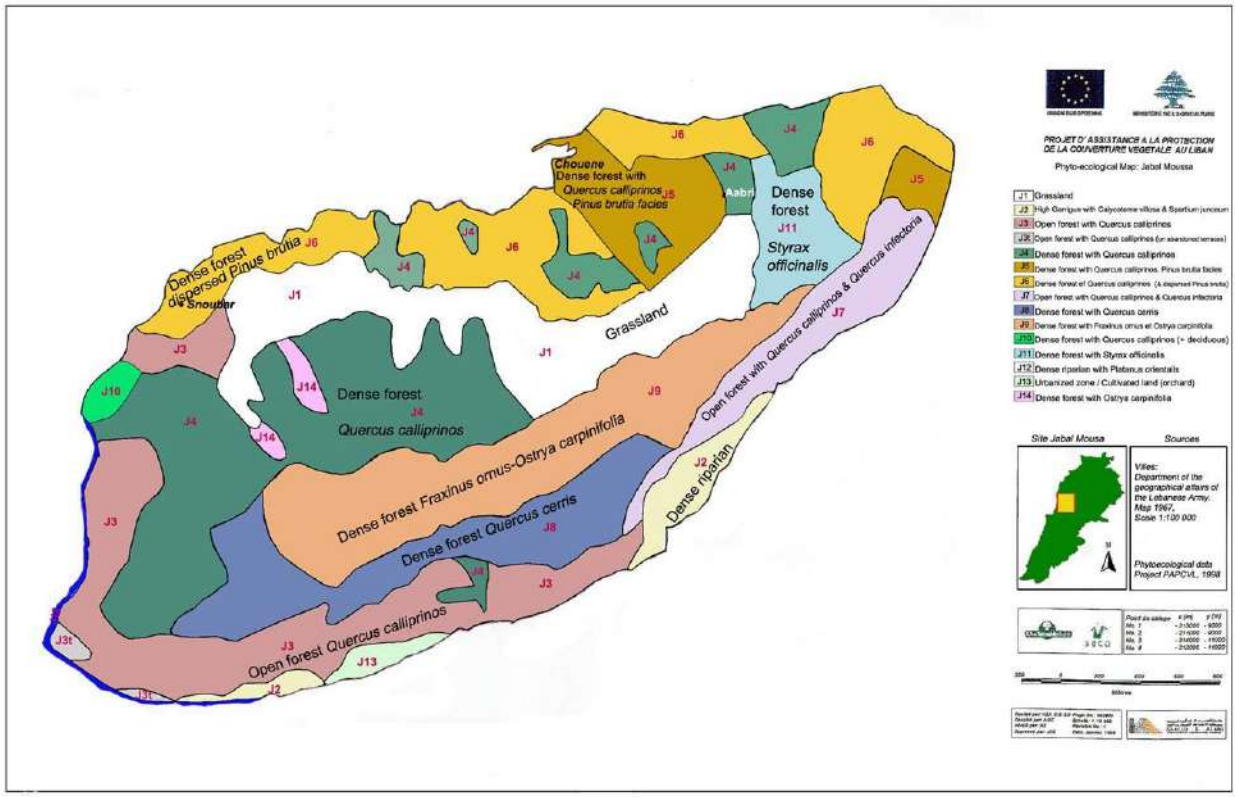

Figure 3. Phyto-ecological map of Jabal Moussa (source: Khatib and Alami)

A field visit was conducted to the study area on 14-5-2016 to describe the general physical characteristics of the site landscape (Figure 4). 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.

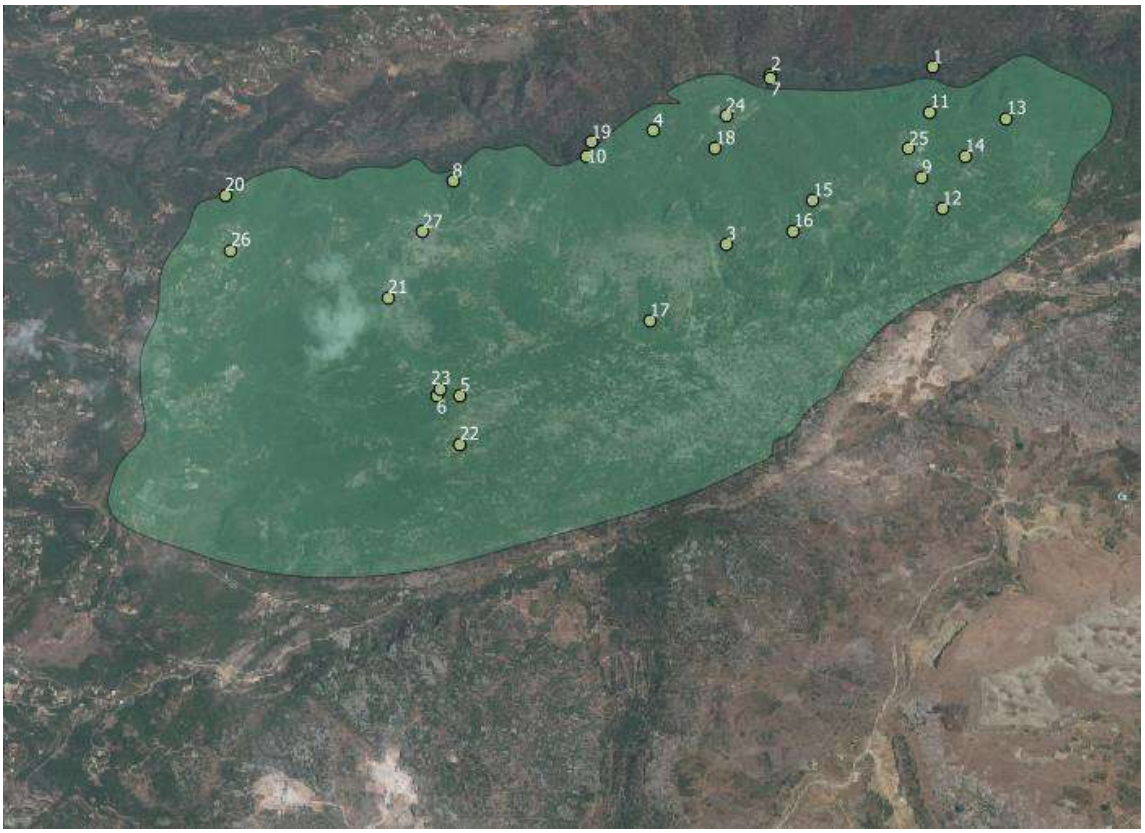

Figure 4. Expansion of the natural landscape in JM (polygon highlighted in green) and its surrounding (a description of coded numbers is presented below).

Table 1. 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 Jeryes 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 Taqla
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 5). Also, there are many areas covered by abandoned agricultural land and settlement.

Figure 5. Overview of the forest area from the area of Chouan

The area in Chouan is frequently visited by many tourists and visitors throughout the years and especially in the spring and summer seasons. Infrastructures for visitors have already been established in the area (Figure 6).

Figure 6. Infrastructure within forested areas for visitors in Chouan

3. Methodological approach

An overall wildfire risk assessment was prepared for JM and its surrounding area. Fire hazard and vulnerability were considered in this assessment 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/landuse of the study area. The analysis included the combined use of field data and very high spatial resolution worldview satellite imagery.

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 for each plot involved the use of a cross mapping between hazard and vulnerability as shown in Table 2.

Table 2. Fire risk scoring matrix

Vulnerability / Hazard	Low	Moderate	High
Low	**Low**	**Moderate**	**Moderate**
Moderate	**Moderate**	**Moderate**	**High**
High	**Moderate**	**High**	**High**

4. Results and Discussion

Three maps were produced, namely, fire hazard, vulnerability, and risk (Figure 7, Figure 8, and Figure 9). Percentages of spatial coverage of classified classes are provided in Figure 10. 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 surrounding.
- 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.

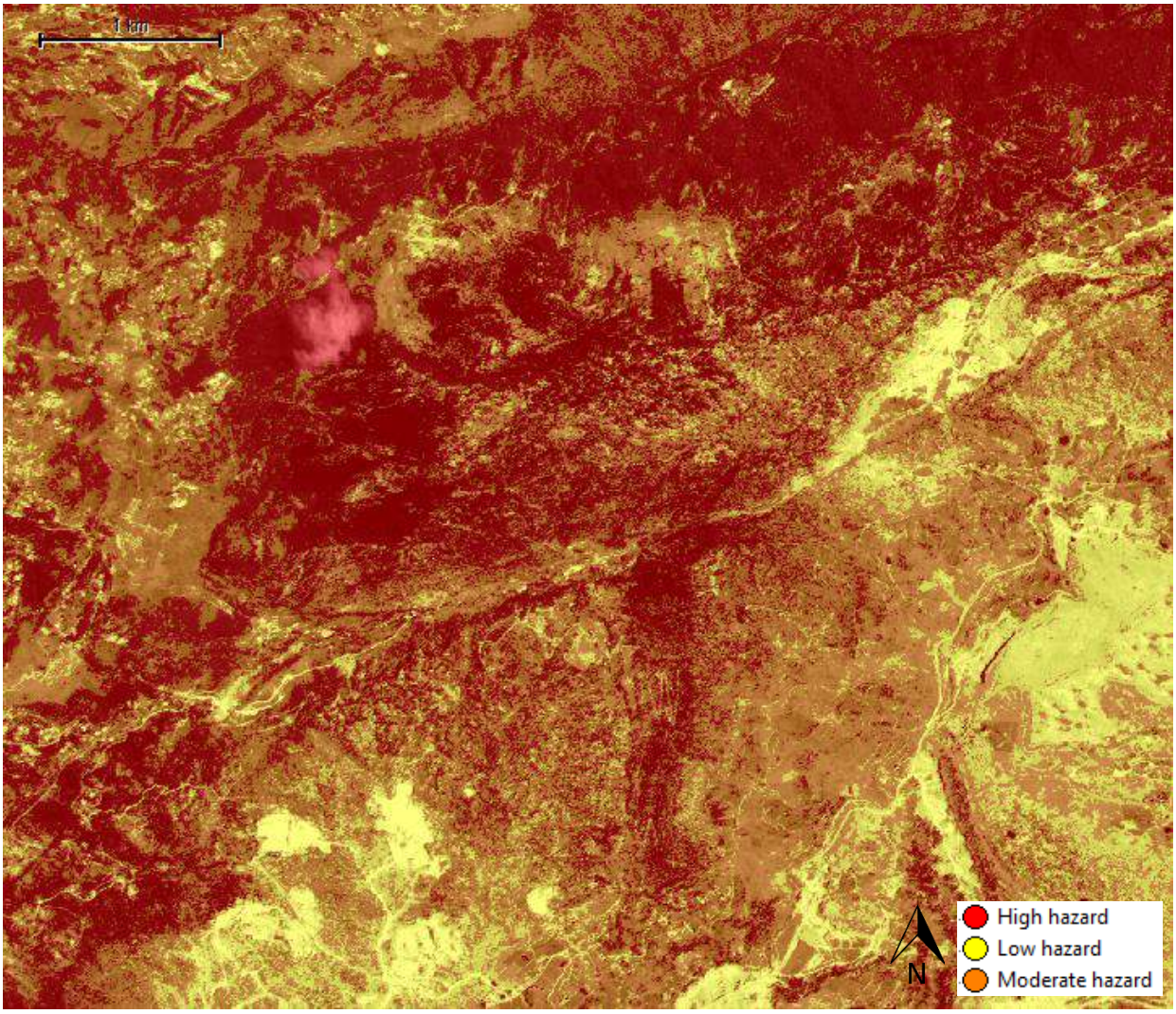

Figure 7. Fire hazard map of JM and its surrounding

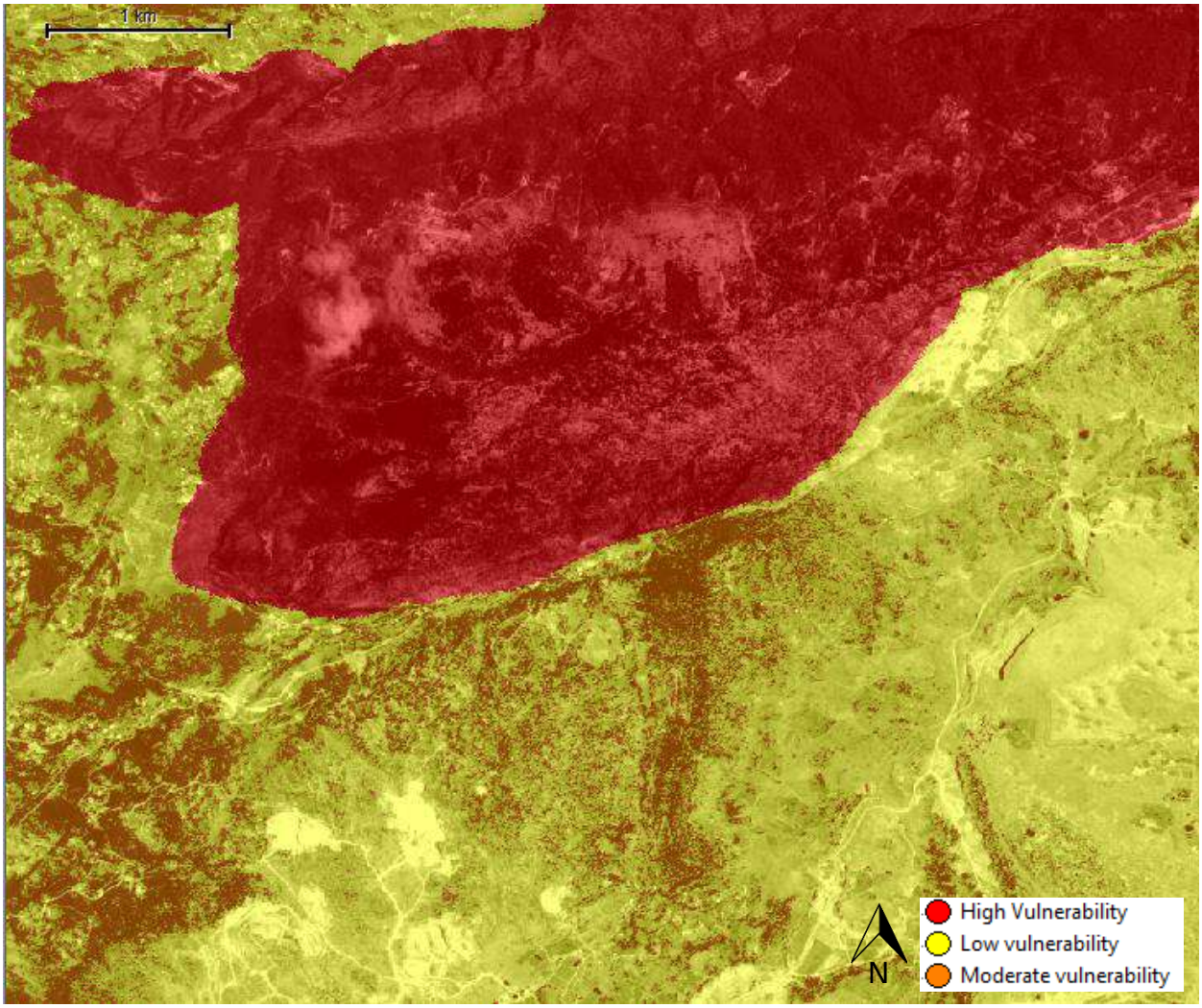

Figure 8. Fire vulnerability map of JM and its surrounding

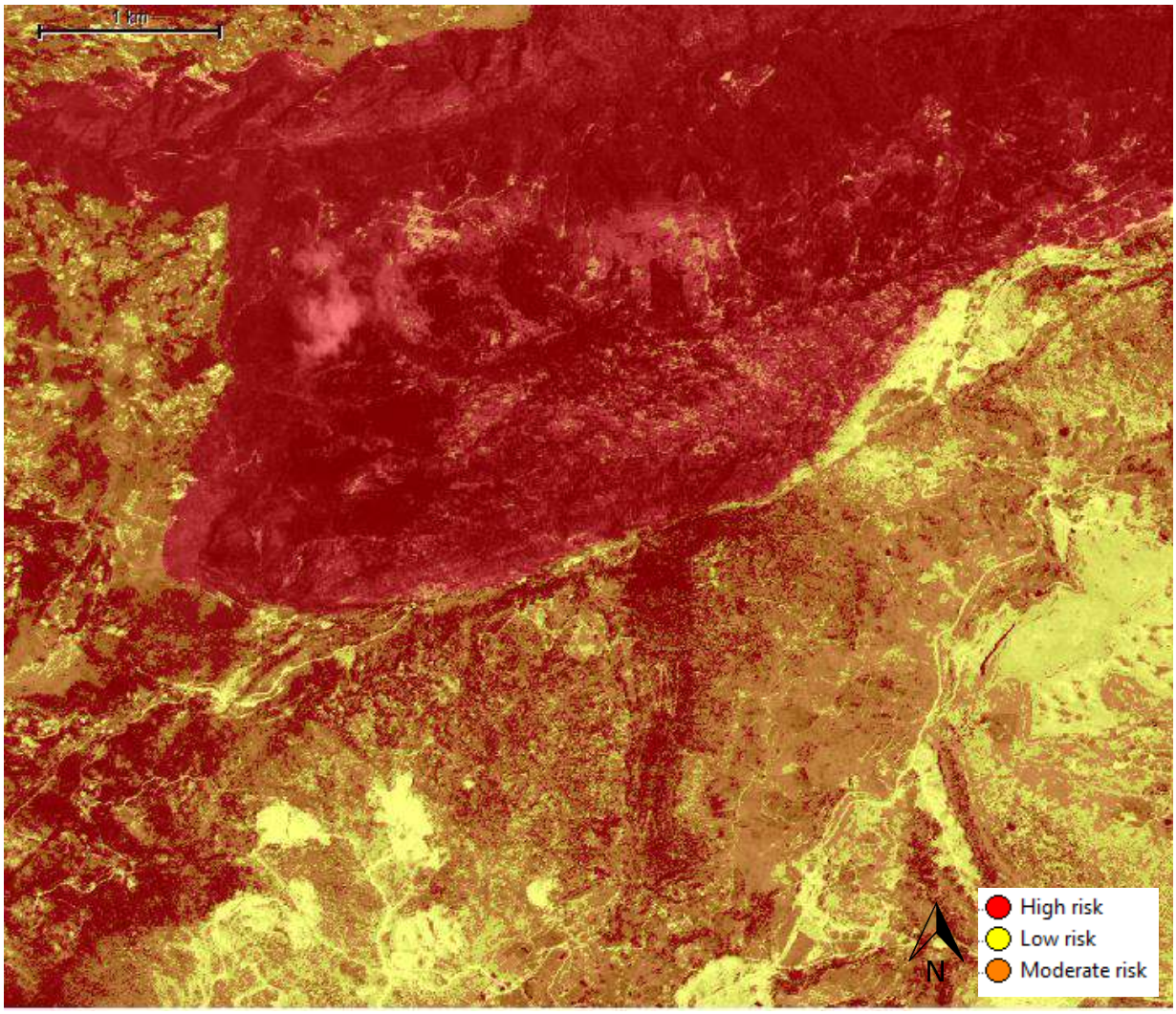

Figure 9. Fire risk of JM and its surrounding

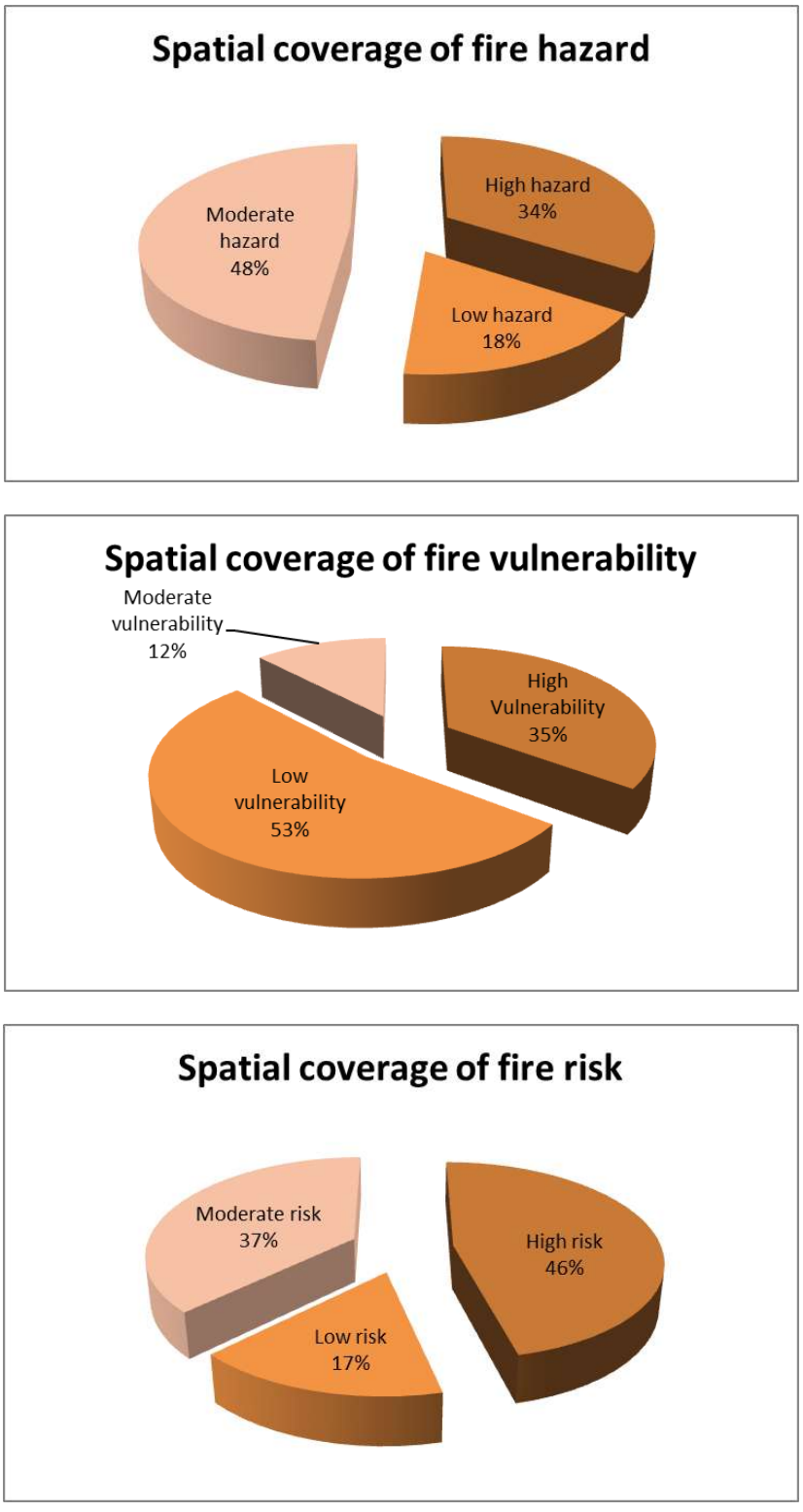

Figure 10. Spatial coverage of fire hazard (upper), vulnerability (middle), and risk (lower) classes

5. Applying Firewise-Lebanon

As described in the Firewise-Lebanon 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 for wildland fire.

Reducing fire hazard

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 the JM forest include:

- Pruning and thinning forest fuel
- Managing thinning debris and slash

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.

In the case of JM forests, fuel management practices can be applied to strips of land. 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 on the borders of very high risk areas
- Creating fuel breaks on the borders of very 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 is 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.

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 11 and Figure 12. All proposed interventions are listed in Table 3.

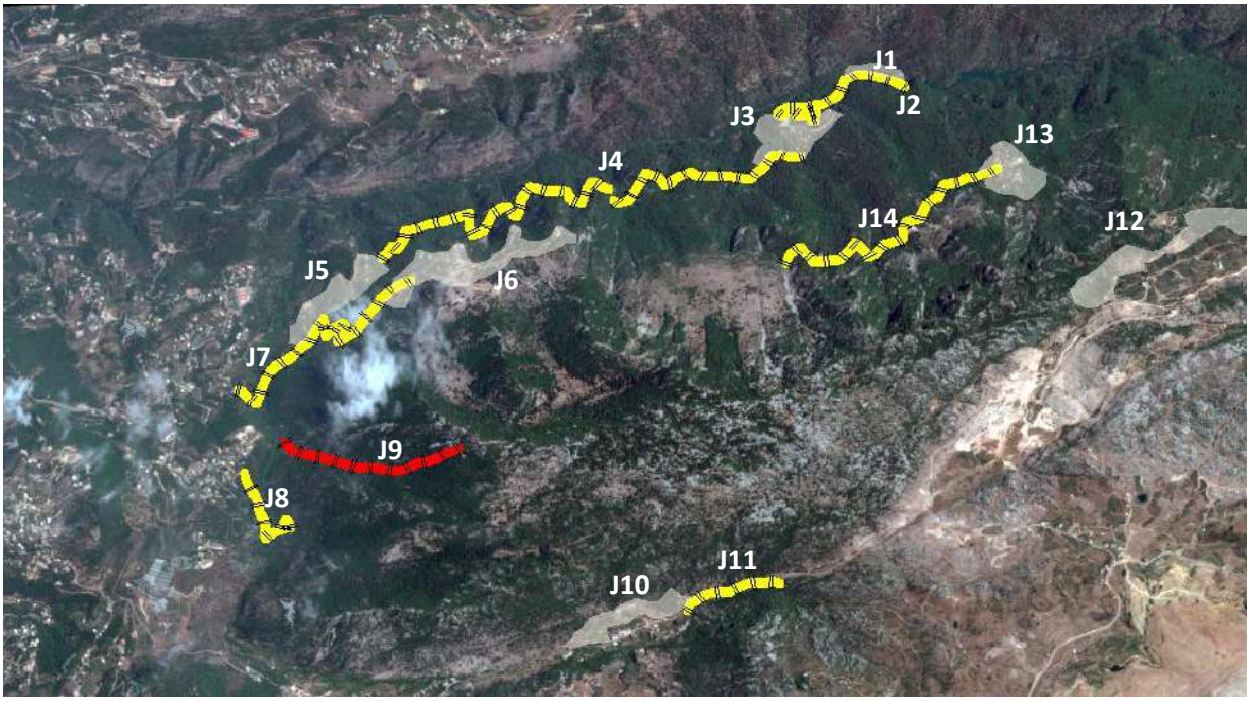

Figure 11. Overview of suggested fire breaks (red line), fuel breaks (yellow lines), and fuel treatment (polygons) in JM

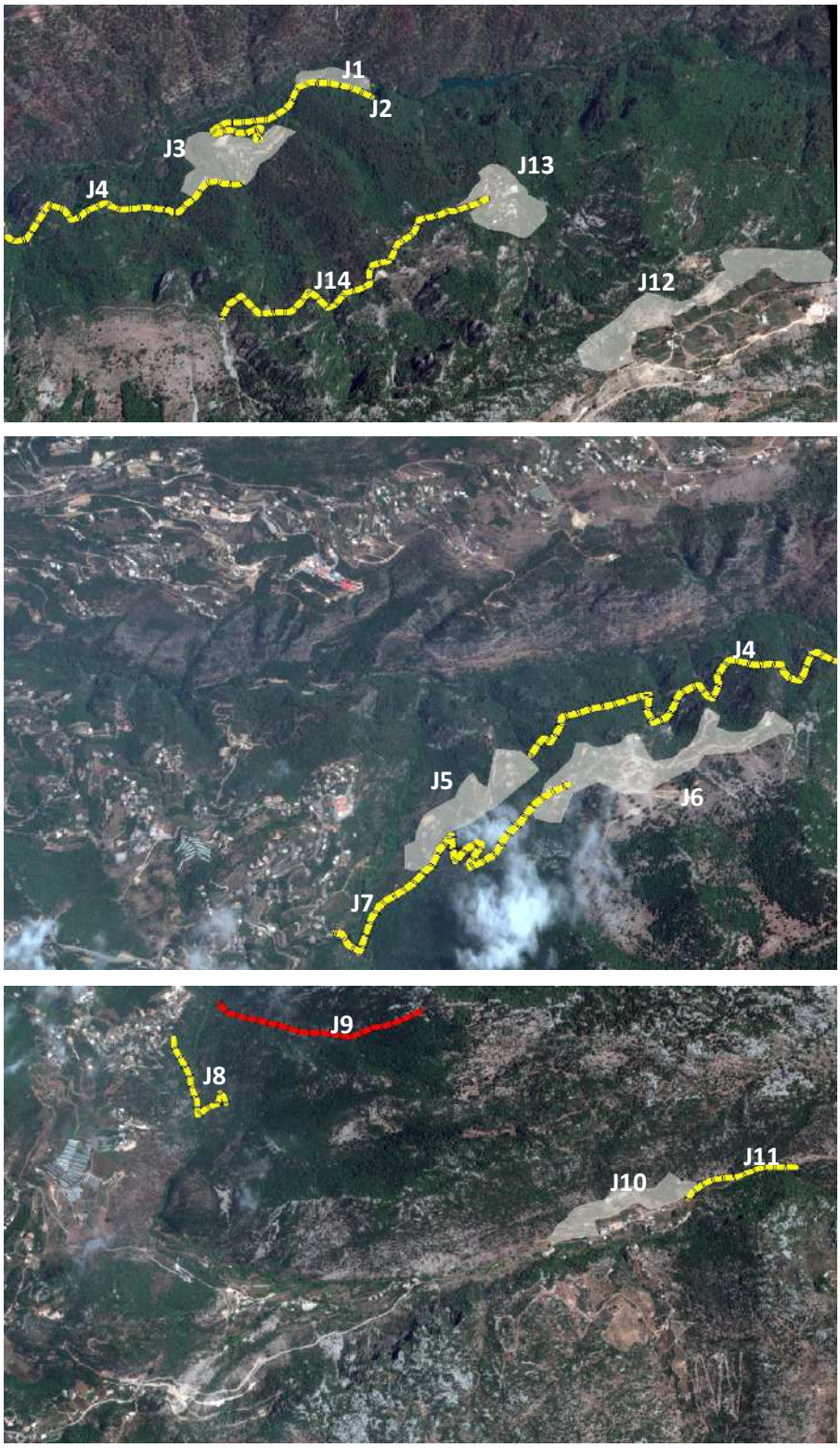

Figure 12. Subsets of suggested interventions

Table 3. List of proposed interventions

ID	Type of intervention	Notes *(widths of fuel and fire breaks depends 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

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.

Managing exiting waste disposal sites and waste burning

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 13) and waste burning points (Figure 14) 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 13. Waste burning in Chouan

Figure 14. Burning wastes close to highly combustible fuel

Also waste disposal points along the road to Chouan (Figure 15) should be cleaned and warning signs from throwing garbage on these sites should be displayed.

Figure 15. Uncontrolled waste disposal along the road to Chouan

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.

Public awareness

It is also recommended to display warning signs about the risk of fires (Figure 16). Warning signs are mounted and displayed in areas easily accessible by visitors and hikers among others.

Figure 16. Examples of warning signs produced within the "Firewise-Lebanon" project

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 was produced and published by IOE-UOE/LRI (2014) in both Arabic and English (Figure 17). It is recommended that community groups in JM and its surrounding refer to such guidelines for future activities in relation to fire risk management.

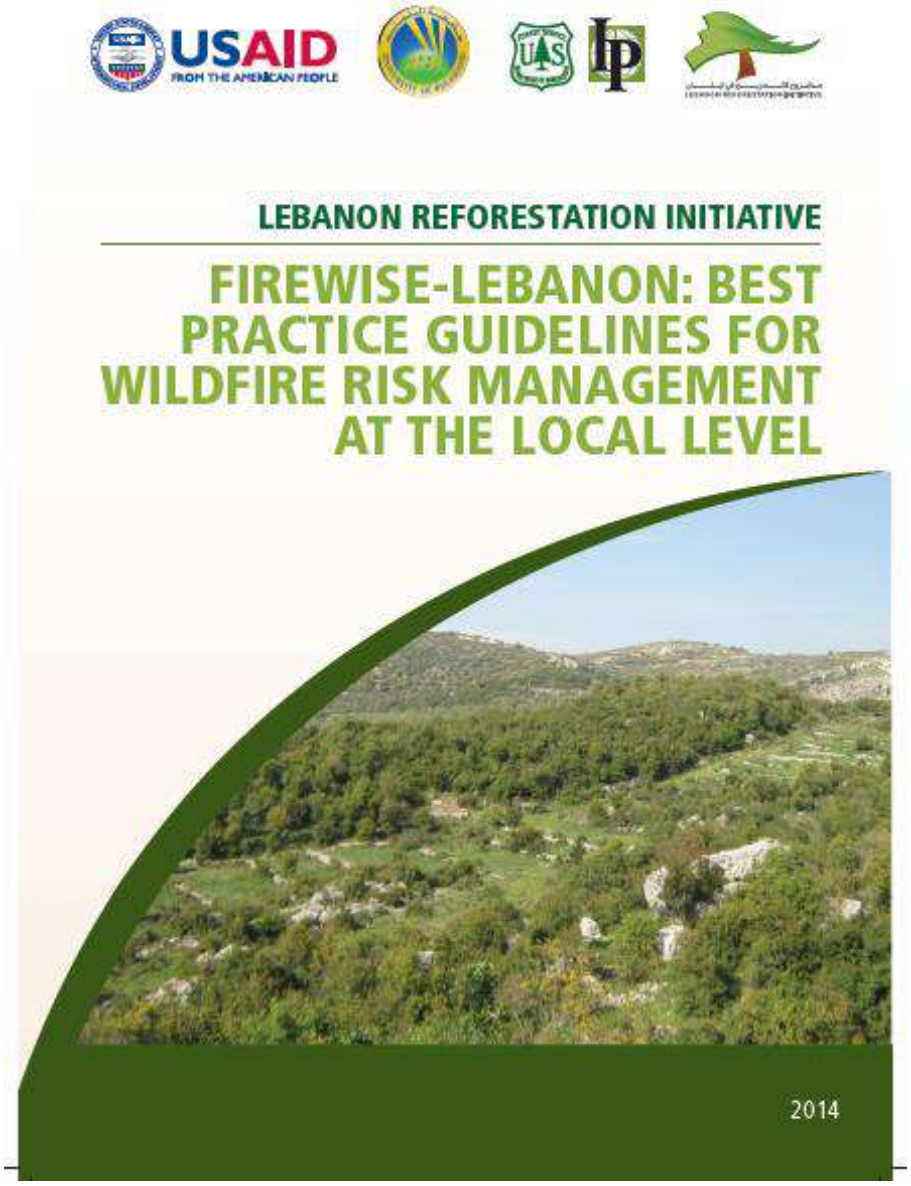

Figure 17. Firewise-Lebanon best practice guidelines for wildfire risk management

References

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 Reforestations Initiative, Lebanon.