

Factors affecting the vulnerability of houses to wildland fire in the Mediterranean region

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Abstract

Knowledge of the factors that make houses and other structures vulnerable to fires in wildland-urban interface (WUI) areas is a key for planning the development of such areas and for taking preventive steps to protect individual homes. Following the wide recognition of the WUI problem in the 1980s a lot of work has been produced in this direction in the United States, while similar work has been carried out in Canada and Australia. One of the main objectives of this work has been development of guidelines aiming to reduce the vulnerability of structures.

In this paper, it is tried to review the factors identified as dictating the vulnerability of homes internationally and to compare them with the specific, quite different, prevailing conditions in the WUI areas of Mediterranean Europe.

Introduction

Knowledge of the factors that make houses and other structures vulnerable to fires in wildland-urban interface (WUI) areas is a key for planning the development of such areas and for taking preventive steps to protect individual homes. Following the wide recognition of the WUI problem in the 1980s a lot of work has been produced in this direction in the United States, while similar work has been carried out in Canada and Australia.

The problem has also appeared in the Mediterranean region of Europe, mainly along the extensive coastlines but also close to metropolitan areas. It has become quite prominent in the 1990s, and this fact is demonstrated by the interest of the European Commission which has currently funded a series of research projects that deal with the “fires in the WUI problem” (WARM, FIRESTAR, SPREAD). In the meantime, forest management and fire protection agencies in the countries of the region have issued guidelines for the public and the authorities on how to build and maintain homes and how to plan settlements in the developing WUI areas. As a rule the source of inspiration of such guides is the work and the publications of the countries mentioned above (USA, Canada, Australia).

However, close observation of statistics and case studies in regard to damages from WUI fires, indicates that they are quite different between the various countries around the world. This is due to many things being different. For example, differences exist in wall and roofing materials, vegetation types, size of lots, type of occupancy, owner behavior, firefighting capacity, legislation, law enforcement, insurance levels, etc. Often, differences exist also between European countries. As a result, the factors proposed, as dictating the vulnerability of homes and the guidelines needed for protecting homes and settlements, may be quite different for the conditions prevailing in the WUI areas of Mediterranean Europe. A critical evaluation is needed before they are applied in European conditions.

In this paper, it is tried to critically review these guidelines and the factors proposed as dictating the vulnerability of homes and compare them with the quite different prevailing conditions in the WUI areas of Mediterranean Europe.

Factors affecting house vulnerability

The number of scientific or technical publications listing the factors that affect house vulnerability to forest fires is really great. Sometimes, it is unclear which ones draw upon the others, but some examples of substantial contributions, at least in the USA, can be found in a guide by the California Department of Forestry (1980), in the work of J. Cohen (Cohen 1995, 2000) and more recently in De Jong (2003). The most commonly identified factors in general fall into the following categories:

- Fire behavior to which a house is exposed, as affected by fuels, weather and topography
- House location, design and construction materials
- Flammable materials outside but close to the house
- Flammable materials inside the house
- Fire protection infrastructure
- Firefighting capacity by firefighters
- Firefighting capacity by owner

Each of these categories is examined in the context of Mediterranean Europe, in some detail, below.

Fire behavior

Mediterranean forests are notorious for their fire regimes. The frequency of burning is generally high and fire behavior is very intense. However, the heat loads are not necessarily higher than those observed in some other (e.g. continental) environments. In the summer, the fuels are very dry. Tree crown and shrub consumption is heavy. As a rule, in most summer burns, litter and duff burn completely.

Fire spread rates of more than 4 km/hour are not uncommon in maquis shrubs and pine forests. In such cases, even well organized and fast responding firefighting resources may reach WUI settlements after the fire or, even if they arrive on time, may have difficulty protecting the structures.

Fuels

Fuels are a major determinant of fire behaviour. In Mediterranean Europe biomass production is high while decay is slow. As a result fuels accumulate relatively quickly and fire return intervals are quite short. Fire is a natural element of Mediterranean ecosystems and if fuels are not removed actively through harvest, grazing etc. most forest areas have a very high probability of burning, often more than once, within a person's lifetime.

The use of biomass for heating, cooking and for animal feed in the past kept fuels, especially around villages, under control. Fires would slow down and lose intensity when approaching inhabited areas. Unfortunately, this practice has gradually been abandoned in the last 3 decades, as people turned to the convenience of using electric power, oil, etc. for their energy needs. The same is also true, in regard to biomass reduction, for modern settlements. Forest fires nowadays reach and enter villages and settlements alike when there is no planned and applied fuel management intervention in place.

In tall Mediterranean forests the abundance of light permits long crowns reaching the surface fuels. It also fosters the development of a substantial shrub understory. As a result forests are prone to crowning fires. Furthermore, prescribed burning for fuel reduction is not easy in most cases, except for maintaining an initial manual or mechanical fuel treatment.

Weather

In the Mediterranean, temperature easily exceeds 40° C in the summer and relative humidity drops to less than 20% quite often. Under those conditions fire brands produced by a forest fire become a tremendous threat. They spread the fire faster creating new spot fires ahead of the fire front, they minimize the effectiveness of firebreaks for stopping the fire and they make fire control efforts more difficult and risky. Furthermore, in the case of WUI areas they allow the fire to penetrate into settlements, uncovering weak spots and poorly prepared houses.

Another weather characteristic common to most Mediterranean countries of Europe is the occurrence of significant regional winds during the summer. They are very strong and dry, they have well known names (Etesies or Meltemi in Greece, Mistral in S. France, etc.) and they are associated with major fire disasters. Each summer, the weather is nearly guaranteed to “offer” a few days of extreme fire danger.

Topography

Many WUI areas around the Mediterranean are located in rugged topography. This is certainly the case in Greece. Steep slopes, are often selected for the view they offer. In some cases the selection of steep slopes as house location is the result of high population density: Many people want to be away from others. Obviously, such topography leads to intense fire behaviour as the flames preheat the fuels more

effectively increasing fire intensity and rate of spread. They heat the structures more effectively as well.

Conclusions on fire behavior

The conclusion is that fire behaviour in Mediterranean environments, as a factor affecting the vulnerability of houses, can have the worst possible characteristics. It is not impossible to reduce fire behaviour potential, but this needs planning, effort and cost.

House location, design and construction materials

The importance of house location, in relation to the effect of topography on fire behaviour has been explained above. However, this is not the only important influence of location in regard to the vulnerability of houses. Proximity to roads, escape routes, inclusion in a settlement or not, affect the possibility of accessing and defending a WUI house.

The design of houses and the construction materials are two important elements that have kept fire damages to structures in the Mediterranean villages to low levels in the past, even when these villages were surrounded by forest vegetation.

In regard to design, the classic form dictates smaller, shorter houses with inclined roofs that offer less exposure to the flames. Openings (windows, doors) are quite small to reduce heat losses in the winter and intense heating in the summer. Opposite to that, the current tendency is to build larger structures often with irregular shapes and overhangs where convective heat can be trapped. Modern design calls for larger windows and glass doors. Availability of air-conditioning is one of the reasons that allow such an architectural approach. Of course, these openings provide better views but they also increase exposure of the internal parts of the house to the radiation of the flames of an approaching fire, and make glass breaking more probable.

Traditional construction of houses is also changing. This is especially true when contrasting the classic village/rural homes with modern houses built by people wanting to escape the city, to be used either as main residences or as second (vacation) homes. In some cases, flammable materials, such as plastic, particle boards etc. replace traditional less flammable materials. Roofs are a good and important example: In the Mediterranean countries of Europe, where the walls will not burn, ignition of roofs is probably the main point of damage (Figures 1 and 2). In Greece, for example, many houses built in the 1970s and 1980s had a flat roof made of reinforced concrete. While such a roof is clearly non-burnable, aesthetics, and needs for better insulation from heat and water, brought some changes to the roofing preferences of the public. Nowadays, clay-tile roofs, either on the old traditional village style structures or on the new 1990s built homes, are very common in Greece. They are considered safe, as the clay tiles are not flammable, but they have been shown to burn quite often during WUI fires. This is due to ignition of their wooden support frame, especially when this frame is old and weathered, or due to use of flammable tar paper under the clay tiles. The latter cause is a

relatively new construction “improvement”. Firebrands are usually the source of ignition of roofs.

In poor level settlements, it is not unusual to find low quality houses, constructed with all types of materials imaginable, from Styrofoam to particle boards, to sheets of plastic, to shade kiosks with roofs made of straw or cane. In such cases the vulnerability of houses tends to be equal to the weakest (i.e. more flammable) of these materials.

Flammable materials outside but close to the house

When discussing vulnerability of houses, it is easy to identify a multitude of elements outside the house that may burn, bringing the walls and other parts of the structure close to or in touch with the flames. Nearly all the international literature on the subject makes reference to these elements that can be found outside a WUI house:

- Wooden decks (or made of other flammable materials)
- Wood piles
- Flammable liquid and gas storage (gas tanks.)
- Dead vegetation which has not been cleared (such as cured grasses, leaves and needles mainly on the roof)
- Flammable live vegetation close to, or in contact with, the house.

In the Mediterranean countries of Europe the extent of the contribution of each of these factors varies greatly. It depends on the situation and traditions of the country but also on the characteristics of each specific area (planned settlement or unplanned, legal or illegal, high-level vs houses of poor people). In general, flammable decks are less of a problem, since they are mostly made with non-burnable materials (reinforced cement, ceramic tiles, marble). Flammable liquid and gas storage in large tanks is not as common as elsewhere, but, especially in poorer and/or illegal areas it is not uncommon to find exposed barrels of fuels or wood piles. Vegetation manipulation is more difficult and hence less likely in illegally developed WUI areas. Part of the problem springs from the nature of illegal development: small plots with little room for orderly storage of wood piles, liquid fuels, etc. Flammable vegetation at the borders of the plot cannot be removed and since, due to the small plot size, it is close to the house, it becomes a major source of problems in case of fire. The problem in such poor areas tends to be compounded even further by the education level of the people which is quite low. It is generally quite difficult to pass instill prevention messages to them and to convince them to at least keep their surroundings free from dead woody and herbaceous fuels.

Special mention should be made about the position of power lines. While in many parts around the world, settlements planned from scratch make provision for underground installation of powerlines, in many areas of Mediterranean Europe villages have existed for a long time, before such concerns appeared. Powerlines are generally located above the ground, and they continue to be that way in the modern expansion into new WUI areas. This adds one more danger, as powerlines are a potential source of ignition and a major hazard during firefighting, forbidding, for example, aerial drops of water.

Flammable materials inside the house

Whereas in the United States, in Canada and in Australia ignition of the external parts of a house is a major concern, in Mediterranean Europe, ignition of materials inside a house is a much more common source of disaster. Some of the most obvious and common examples are:

- Nylon curtains
- Rugs
- Upholstery
- Polyurethane furniture

Nylon curtains are present in the majority of homes. The hot summer conditions in the Mediterranean make it more than probable that windows are kept open most of the time. If they are left open while a fire is approaching the probability of ignition in the house increases very steeply. Radiation from the approaching flames, while it may be inadequate to ignite structure elements, such as thick pieces of sound wood, at some distance from the flames, may be more than enough to ignite the thin and flammable curtains behind an open window. Sometimes, when windows are left open, ignitions are possible due to the shower of firebrands landing on the curtains, rugs, etc., even when the fire front is still at a considerable distance.

Fire protection infrastructure and firefighting

The new well-planned settlements described in the US publications make effective firefighting possible. The guides for development of WUI areas, always refer to a number of points that when observed carefully, will allow good fire protection and, if needed, quick and safe evacuation of the public. These points, at a minimum, include:

- Accessibility
- Road network condition (width, turnarounds, street signs, ...)
- Water (tanks, hydrants,..)

Of course, there is always reference to the need for availability of good firefighting resources, and considerations about if and when homeowners should stay and protect their homes during a fire episode.

In Mediterranean Europe, there are marked differences in regard to this matter. Although the guidelines above are recognized as having universal merit, possibilities for intervention in the planning of settlements are often limited. Some obvious examples are settlements with a long history, that have been built with inadequate clearances, road widths, etc. and new illegally developed settlements. However, there are also differences in the way people try to protect their homes. In Greece, for example, it is not uncommon to leave WUI homes uninsured. This lack of insurance policy on homes is probably a factor that makes homeowners stay and protect their home during fires. The construction of their homes, as they are mostly made of non-burnable materials, also encourages them to do so, more than their Californian counterparts, for example.

Conclusions

The short review above has highlighted some significant differences that exist between “new-world” countries such as the USA, Canada and Australia, and Mediterranean Europe, in regard to the WUI problem. Although studying the guidelines produced in those countries is clearly useful, realistic and appropriately adapted rules and guidelines are needed for European conditions. This is especially important because public cooperation must be secured before any WUI fire protection plan can work. Such cooperation cannot be achieved if the guidelines are not realistic, reflecting the actual situation.



Figure 1. Damaged roof on a house at the base of Parnis mt (Fili) (27/8/2002). The house was saved by firefighters. The owner was not present.



Figure 2. Destroyed home at Bafi, N. Attica (4/6/2001). The roof was the weak point where the fire entered the house.

These comments do not put in doubt the basic elements that have been identified in literature as determinants of the probability that a house will survive a WUI fire. They rather point towards the need to re-evaluate the way and the extent to which these elements apply. This is part of the ongoing work in the WARM project, which combines theoretical findings and analysis of statistics with field observations during and after real WUI fires. For example, focusing on the Greek situation, which also reflects the conditions in some other areas of Mediterranean Europe, any guidelines to be produced will have to recognize and address some real world problems and limitations to developing safe WUI areas, such as:

- In Greece the forest law limits vegetation-clearing works. It is not clear what a house owner may or may not do.
- Lack of land cadastre and lack of development plans lead to anarchy in developing WUI areas.
- The laws are only partially enforced in this domain, as pressure for illegal developments is strong, resulting from the shortage of legal options.
- The size of available lots is generally quite small. As a result, regulations (such as those in California) that demand 10-30 m vegetation treatment zone around houses are clearly not realistic.
- Rules and regulations are incomplete or non-existent in regard to building safely close to forest vegetation. Pre-fabricated houses currently being built in WUI areas are one such example.
- Local road networks are often not made up to acceptable standards. House owners cannot do much about that.

It is hoped that the WARM project, recognizing the real world problems above and combining field work findings with theoretical modeling, will be able to built a basic guide for house vulnerability assessment, with an emphasis on being practical and adaptable under the European environmental, social, and economic conditions.

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