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The wildland-urban interface: a risk prone area in Spain

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Abstract

The spreading of the wildland-urban interface in Spain, related to the increasing sprawl of human settlements and also to the progression of natural vegetation, constitutes a worrying territorial dynamics in connection to the problem of wildland fires. Despite the increase in number of episodes of wildland-urban fires, there is neither social awareness nor political concern on this matter. This results in a shortage of laws and management on these new territories at risk.

Keywords: Urban sprawl, wildfires, spatial vulnerability, spatial planning, land management.

1. Introduction

One of the elements which are contributing to increase vulnerability of territories to wildland fires in Spain the most is the development of situations which could have an impact on buildings and urban areas. This spreading of the threat to goods and people prompts, aside from a risk increase, a rising complexity of prevention, and above all extinction duties.

However, the social perception of this risk prone area remains weak. That is why the consideration of this reality, despite their importance increased surface, has not reached the scale and intensity necessary (with some exceptions) to address a specific treatment from the various public policies with the capacity to intervene in these areas (forest policy, planning, spatial planning, civil protection, etc.).

2. Distribution of wildland interfaces in Spain and episodes of fire

Despite being a reality that has come to define a true landscape of reference for the Mediterranean forest in different areas of the Spanish territory (some stretches of the Mediterranean coast: Costa Brava, Costa Blanca, Mallorca; the metropolitan outer Madrid Barcelona and Valencia), little is known about the surface magnitude of the phenomenon and its spatial distribution. What seems undeniable is that their growing presence in the country is resulting in an increase in episodes of wildland-urban fire in Spain, such as those that accompanied the great waves of fire that affected the Canary Islands (2007) and Galicia (2006), which are increasingly common in heavily urbanized areas such as Madrid and Catalonia.

Figure 1. Tourist housing developments on the Mediterranean coast (the *Costa Brava*, Catalonia) (Source: Observatori de Paisatje. http://www.catpaisatge.net/esp/index.php.)

This increased vulnerability is determined by a spatial evolution in which two factors are present. On the one hand, a dynamic progression of vegetation resulting in greater continuity (both vertical and horizontal) of woodlands, which facilitates the spread of fires (Badia et al., 2002). And, secondly, by a marked tendency to spread of urbanization, especially in metropolitan and coastal areas. Interaction between both factors is derived from a multiplicity of wildland-urban interface situations.

a) Evolution of interface territories

The first attempt at mapping of this reality in Spain at national level has been done through the establishment of contact zones between forest areas and urban areas in 1987 and 2000 (Montiel and Herrero, 2010). The data used in this study tell us about 1.1 million ha of areas of wildland-urban interface in 2000, an increase of 6.8 per 100 from 1987 (see Figure 2).

WUI are particularly dense in Galicia, Asturias or Canary Islands, regions marked by their highly scattered system of rural settlements. This situation especially affects those areas with the highest levels of urbanisation too. That is the case of the metropolitan rings of Madrid, Barcelona and, to a lesser extent, Valencia; also noticeable are the concentrations present at the Mediterranean coast, an area of higher intensity of touristic uses (*La Marina* in Alicante, el *Ampurdán* in Girona or the *Costa del Sol* in Málaga).

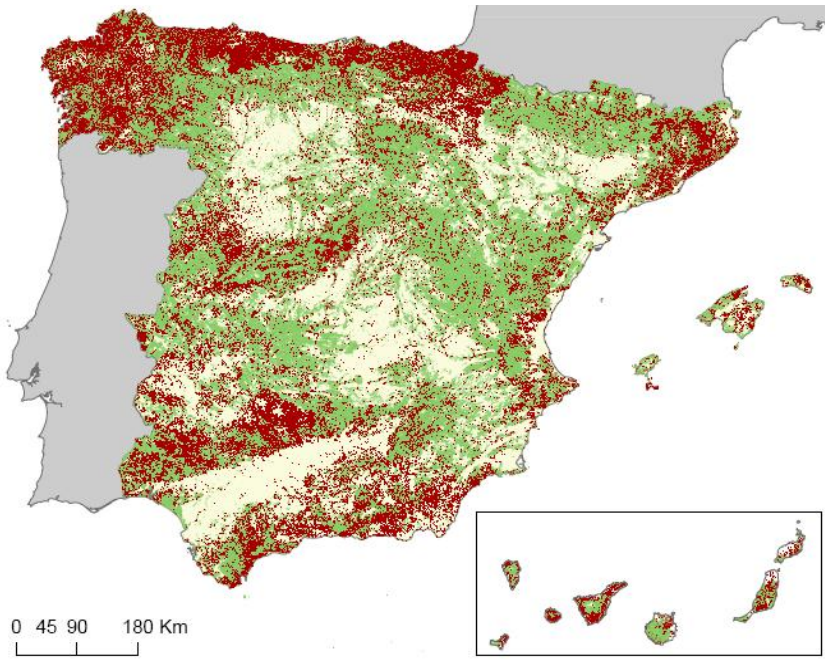

Figure 2. Areas of wildland-urban interface, 2000. Source: Montiel y Herrero, 2010.

The rising territory urbanisation, main reason of the advance of interfaces

The spreading of interface situations is mainly related to urbanisation processes and the spatial patterns adopted in those processes. The intense process of suburbanization of the American city itself, which was the origin of the emergence of the phenomenon of interfaces (first in California and later in other states), arrives in Europe (and Spain) with several decades of delay. But despite its later development, it is a well established process, which has spread through the areas of greatest increase in urbanization of western Europe during the last fifty years (European Commission, 2006; Font, 2007).

The progression of natural vegetation

The other element which contributes to the spreading of interfaces is the progression of natural vegetation against farmlands. Statistical data on the evolution of land use in wildland areas (*Corine Land Cover*, *National Forest Inventory*) are slightly contradictory. In general, wildland has stabilised or slightly increased in Spain in the last twenty-five years. Which seems to be more indisputable is the advance of wildland densification. These are qualitative changes of particular significance which also affect the increase of continuity of forest uses in especially sensitive areas like town farmlands or city outskirts and coastal areas.

Thus, the boundary of the wildland-urban interface moves not only in terms of irresponsible urbanization on high-risk areas, but also more stealthy, as a result of the gradual loss of agricultural use in areas particularly sensitive causing substantial changes in the relationships between human settlements (which never before had a perception of being located in areas at risk of forest fires) and its immediate surroundings.

b) The problem in Spain: recent episodes (Catalonia, 2003; Galicia, 2006; Canary Islands, 2007)

The fire regime in Spain entails a higher and higher relative importance of large wildfires, which, under extreme weather conditions, are beyond extinction capacity. One of the elements which come together with this general evolution of fires is the appearance and progressive significance of wildland-urban fires, aspect linked significantly to recent catastrophic events that occurred in Spain (Catalonia, 2003, Galicia, 2006; Canary, 2007). At these events, the large population affected was necessary mass evacuations, causing a great complexity of the proceedings of extinction, which ceased to be mere forest fires to end up becoming true civil protection emergencies.

The analytical work undertaken since the fire of *Grup de Recolzament d'Incendis Forestals* (GRAF) of the *Generalitat* of Catalonia have led to modeling the behavior of large wildfires over the past 40-50 years, the conclusions may be described as general. According to this evolutionary model, which relates the characteristics of fires with changes in fuel availability in the forest (continuity, density) and experienced territorial changes (agricultural abandonment, loss of function of forest, urban sprawl, etc.), it is possible to define four generations of fire (Rifà and Castellnou, 2007). According to this model, in Catalonia (and in general in Southern Europe) the third generation of fire that appears in the years 90 (crown fires that exceed the capacity of intervention tactics; appearance of multiple secondary spots to progress to jumps long distances) expressed concern behavior in the next decade: the chance of spreading to other types of fuels (developments), more and more numerous in relation to processes of urban sprawl. This allows us to speak of a new generation of fire, the fourth, with new challenges for fighting services (Castellnou, Rodriguez and Miralles, 2005).

In fact, some of the fires occurred in Catalonia in the uniquely warm August 2003 showed these characteristics (Sant Llorenç Savall, 4,579 ha; Maçanet, 1,279 ha; Platja d'Aro, 429 ha). Extreme weather conditions of temperature and humidity, combined with strong winds and atmospheric instability, leading to crown fires with multiple secondary spots that spread to the neighborhoods across (Castellnou, Rodriguez and Miralles, 2005).

The episodes of forest fires in Galicia lived between 4 and 13 August 2006 (about 80,000 ha are affected, 4 deaths) had different characteristics. Absolutely unprecedented, was characterized by rapid and widespread conversion to an issue of public safety and public order to be largely urban-forest fire that caused a great alarm and a feeling of insecurity (Informe, 2006). The large number of fires (2,055) and simultaneity (peak of 300 active fires, with an average of 5 spots) was added to the risk component of the resident population: 51 100 of the fires were declared level 1 and 2 (those with risk to life and property of a non-forest) (Xunta de Galicia, 2006). A total of 9,262 settlements were affected, mainly located in coastal provinces of A Coruña (Costa da Morte, district de Compostela) and Pontevedra (Salnés, county of Vigo), with a perimeter of wildland-urban interface of 788,160 meters linear (Xunta de Galicia, 2006).

Two major fires originated in Tenerife (Los Realejos, 18,095 ha) and Gran Canaria (Tejeda, 19 190 ha) in late July 2007 calcined an area larger than that recorded in the whole archipelago for all forest fires in the twenty-two previous years (MMARM, 2008). Along with the relative importance of reaching a small number of events that are beyond the capacity of extinction, this episode also revealed the emergency component of civil

protection that forest fires may actually cause, to affect a large number of settlements and causing the evacuation of more than 12,000 people. Started in large masses of Canary pine, also spread by agricultural environments of the villages that private maintenance is traditionally performed around residential areas were destroyed by fire, which reached and passed through several rural communities.

Without reaching the drama of these episodes, examples of large fires that turn into civil protection emergencies affecting urban areas have been happening in recent summers (Turre, Almería, July 2009).

This is the reflection of higher territorial vulnerability, linked to the increasing importance of scattered estates on the Spanish territory, but also has to do with the progression of natural vegetation and looser management in many rural villages' surroundings.

3. The management of the wildland-urban interface

The necessity of managing WUI arises from several viewpoints, which include the stages of emergency prevention and extinction as well, and which have to do with the actions involved in different public interventions (spatial planning, forest and fire policies, civil defence).

a) The responsibility of spatial planning for the increase of territorial vulnerability

Spatial planning is responsible for the spreading of interfaces. The main contribution to this issue would be stopping its progression by adopting a more sensible territorial model, able to include the relations between decisions regarding land uses and the existing fire regimes in a specific territory (Pincetl *et al*., 2008). However, to do that, certain problems must be deal with first.

The scarce consideration of risk as an element associated to scattered urbanisation

The negative perception of low-density urbanisation processes as one of the components of territorial unsustainability (economically and operationally inefficient, socially segregated, environmentally harmful) (Indovina, 2007, etc.) doesn't include the fact that they also contribute to increase vulnerability of large territories to the risk of wildland fires. And this is not true in general, or in areas heavily hit by urban forest fires (eg, Galicia): is not met the highest disaster-based process, whereby the intensity of attention to natural hazards depends on recent experience, dismissing the long-range historical approach characteristic of the scientific assessments of risk.

The necessary sectoral approach to the problem

According to the planning regulations, spatial planning must incorporate in its determinations the delimitation of the territory of risk through environmental sustainability report of plans for urban development, on establishing a generic regulatory use restriction edificatory. However, the definition of risk areas must be accredited by the sectoral planning, which is responsible for evaluation, so that only their maps have a legally binding basis.

The definition of risk territories must be supported by sectoral planning (forest, wildland fires). However, these maps are drawn with different purposes (fire prevention and extinction) which don't meet the requirements of spatial planning. It should, therefore, set minimum standards for hazard mapping for determining the territorial scope of the danger with land uses that overlap. And this at different scales: (i) Regional. General framework for other plans and programs in greater detail, sufficient to identify potentially threatened areas to avoid, for example, more settlement activity; (ii) Local. You need a more detailed hazard assessment. Should be conceived as a binding basis for building permits.

From this base, could be chosen risk management strategies specific to certain hazard-prone areas: conservation of area free of development, restrictions on certain sensitive applications, creating conditions more restrictive building (height, materials), etc. (Fleischhauer, Greiving and Waczura, 2007).

The technical difficulties involving management and the necessity of new approaches

Along with the problems of dependence on sectoral planning, spatial planning is faced with obvious limitations to deal with this new territorial status from standard technical solutions. The risk management options by the spatial planning (restriction of settlement processes, regulation of land use) necessarily go through an exercise of zoning. And despite the limitations and criticisms of the zoning; criticisms revolve its essentially static character compared to a spatial reality that is inherently dynamic, and its inability to provide medium-term patterns of land transformation (Ezquiaga, 2009).

Territorial management from zoning must lean on the consideration of territorial dynamics (scattered urbanisation, progression of natural vegetation) key to define risk territories. Thus, planning must also advance towards the adoption of a strategic viewpoint, directed to detection and regulation of the most relevant and innovative processes with spatial incidence.

b) Sectoral planning (forest and wildland fire policies): a recent and insufficient incorporation of the concept to laws and practices

The specific approach to the problem of interfaces in Spain takes place framed within the law on civil defence (1993). It is precisely under this rule when it starts to define a specific treatment of the problem of interfaces in Spain. In particular, noting the obligation to draw up plans for self-protection "to isolated villages, housing estates, camping sites, etc., which are located in areas at risk." However, this general duty has not only relevant in most Autonomous Communities, which have not generally developed such plans.

In turn, forest legislation finally includes the concept of WUI, although in a wide, imprecise manner, linking it to the problem of wildland fires. The Forestry Act 2003 refers to these areas as including "the developments, other buildings, works, electrical installations and transport infrastructures are located on forest land and its surroundings, which may involve risk of fire or be affected by these "and is left to the autonomous communities to identify more precisely these areas, establish the necessary safety standards and regulation of activities that may create a risk of fire.

From this general framework, some Autonomous Communities have gone into the specific approach of the problem in depth. Advances took two main paths: on one hand,

specific planning and management of these spaces; on the other, assessment of territorial vulnerability prompted by urbanisation processes in forest land.

The management of interface areas

The obligation of protective perimeter strip of variable width aiming at reducing fire intensity, together with other complementary actions, is the most usual approach to the management of these spaces. Catalonia has pioneered it. The importance that urbanisation processes in forest land gets in this region and the rising importance of wildland-urban fire explain the interests of Catalonian authorities in developing an efficient management system (legal support and subsidies) (Terés *et al*. 2007).

Andalusia, Aragon, Canary Islands, Castilla-La Mancha, La Rioja, Madrid and Valencia have also established this obligation, with varying widths (15 to 25 m). Extremadura's example is perhaps reaching greater technical complexity. The plans called Peri Prevention of forest fires pose the execution of a suburban strip Edge (400-200 m from the edge of urban land) with the responsibility lies with the municipalities. Among other activities (roads, water points) in these bands will be two 80-m firebreaks: a surrounding urban land (to avoid spreading toward the mountain), and one outside, to prevent forest fires threaten people ; in them will reduce the fuel, eliminating long grass (García and Carrascal, 2007).

In the case of Galicia, the growing importance of the problem results in a more comprehensive treatment and specific policy, which takes into account the special considerations to a largely dispersed rural settlements and the dynamics of forest area in the region. A strict regulation of the afforestation in the vicinity of urban and rural communities, reaching its prohibition, and promoting the management of plant biomass in the border areas, with subsidiary action programs by the administration .

In short, the few preventive measures on the interface developed by legislation and planning documents of regional governments have arisen from the dual consideration of the interface: (i) as a vulnerable area, which is necessary to develop actions to protect people and property from fires, and (ii) as a generator of risk, taking measures to prevent ignition and possible spread of fire from urban areas to forests.

The incorporation of the variable population vulnerability into risk maps

As noted above, only the definition of areas of risk by sector planning (fire, forest) is binding for all other plans. For this reason, the changes that are starting to occur in some regions regarding the drawing of those risk maps are particularly relevant. On one hand, the inclusion of new vulnerability parameters linked to the presence of villages and goods potentially threatened by fires; on the other hand, the expressed will to declare spaces which should remain apart from urbanisation processes.

The Autonomous Communities that have gone furthest in this regard are the Balearic Islands, Catalonia and Galicia. Since 2007, Galicia explicitly states that the zoning of the territory according to the spatial risk of forest fires must incorporate population vulnerability factor, while pointing out the obligation on the part of urban planning tools to incorporate areas defined risk prevention plans and defence against wildfires district. This evaluation takes into account the population density in forest area, the number of settlements and the distance between them and the presence of elderly population (Xunta, 2009).

In this sense develops special plan against the risk of forest fires in the Balearic Islands. In this case, the calculation of population vulnerability incorporates *occupancy* (presence of buildings in forest soil), *boundary* (contact urbanized areas with forest areas) and *scattering* (proximity or distance between the different settlements of population). These calculations help to establish priorities for preventive measures and warn of the difficulties of fighting in these areas. They have great interest for the development of protection plans, which all determinations are to be incorporated by the urban planning for the expansion or creation of new urban settlements on areas or forest environments.

c) Planning for emergencies

The special circumstances in which interface fires take place make this kind of fire be a rising worry for extinction systems, which have to devote more and more time and means to fight these eventualities. It is necessary to tackle a new scenario of forest fires. A new situation in which they combine two main factors: the high intensities that these events can reach and increasingly endangering resident population. On the other hand, must also overcome the added problem of ignorance about the danger of fire if by residents of these areas (most notably in the case of estates), which further complicates the situation (Castellnou, 2005). In this context, the main work lines of emergency planning are the increase of effectiveness of extinction task forces and the raise of awareness of the inhabitants of this kind of spaces.

Awareness and self-protection of WUI residents

The level of awareness of the risk that inhabitants of the WUI in Spain is generally alarmingly low. This lack of awareness is particularly notable in the case of isolated residential areas (often second homes) located in forested areas, campgrounds, and other environments associated with the holiday practice, inhabited by a population of distinctly urban characteristics. But also affects rural communities that until recently had never been affected by forest fires, but now are vulnerable in relation to changes in land cover caused by a lack of management of the immediate environment caused by the abandonment of agricultural practices.

Very few Autonomous Communities have carried out awareness campaigns (Catalonia, Canary Islands). Besides awareness of living in a risk territory itself, these campaigns intend to encourage behaviours of adaptation to risk on owner’s part, aiming at reducing vulnerability of structures. The other great objective is informing about the most adequate way to act in case of fire.

The management of a new wildland fire scenario

The analysis of fires that occurred in campaigns with severe problems of wildland-urban fires makes advisable performing changes in tactics and training of extinction teams to adapt to a new reality characterised by simultaneousness of emergency situations (Castellnou *et al*., 2007). Particularly delicate are the decisions on evacuation or confinement. There is no different strategies previously defined in Spain (as in Australia under the slogan "Prepare, Stay and Defend, or leave early ', or California) (Stephens *et al.*, 2009), but evacuation is clearly chosen as the preferential solution. This led to many clashes with the population, especially in rural areas, as its inhabitants do not readily accept not being able to directly defend their properties against fire (Canary, 2007).

Figure 3. Protection perimeter strip 25 m in a neighborhood of Sierra Calderona (Valencia, Spain).

4. The problem of the WUI: between unsustainability of urban dispersion and agricultural abandonment

The advances in knowledge of this reality in Spain haven't resulted up to now in a widespread social attitude which considered wildland-urban interfaces a territory at risk. People don't see the increase in number of episodes which more and more frequently affect inhabited areas is directly related to certain territorial dynamics which increase vulnerability of the territory. In particular to the increase of disperse urbanisation in rural spaces, both in metropolitan areas as well as in zones linked to touristic development, and to processes of abandonment of agricultural land in particularly sensitive areas (towns' surroundings).

The widespread opinion on the unsustainability of the rising dispersion of settlements doesn't incorporate its contribution to the increase of risk situations linked to wildland fires. Much less are people aware of how processes of abandonment and changes in agricultural practices in the surroundings of villages are substantially modifying wildland fires spread patterns.

In conclusion, despite the interest and notoriety that this reality has progressively acquired, the necessary, sufficient conditions for an adequate consideration of this new risk territory don't occur yet.

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