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Evolution of the legal prevention measures concerning forest fire risk in a context of climate change

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ABSTRACT

In a context of climate change that may increase the extreme events and so the forest fires, the question is to know whether the legal framework is relevant or it should keep on evolving to manage the forest fire prevention risk. Many reports concerning the climate change and also the forest fire risk in France pointed the necessary adaptation of the public policies and the lack of the legal prevention measures. So, the question is what the main legal measures are to be developed or to be implemented in the territories actually exposed to forest fire which could be more exposed to this risk and the territories which are not exposed for that moment but which could be exposed in the future.

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1. Introduction

According to the reports of the Intergovernmental Panel on Climate Change, especially the fifth report (2014), the climate change is expected to have particular consequences of a gradual change in ecosystems, which would affect the nature and distribution of the constituent species of these ecosystems. In particular, expected evolutions include changing the geographical boundaries of the current Mediterranean bioclimatic zone (*lato sensu* Mediterranean), particularly north of the latter and in upland areas. Moreover, other vegetation types currently in place in the extension areas of the Mediterranean climate is by nature much less resistant to drought and high temperatures, which increases mortality of woody taxa. These characteristics make them particularly flammable and therefore increase the risk of fire. For that reason, Roman-Amat report (2007) underlined potential shifts in vegetation which should be anticipated to prepare French forests to climate change.

The impact of climate change on vegetation and species raises questions of the exposition of the population and goods situated close to the fire prone natural areas and the control of future urban development. The land abandonment leading to fuel accumulation (Piñol et al., 1998; Cramer, 2001; Pausas, 2004), the climate change and the land-use dynamics (Léon, 2008) are factors of increasing fire risk with a higher fire frequency, especially in the Mediterranean region where fire risk is still increasing (Alexandrian et al., 1998). Moreover, Rigolot (2008) infers an increased fire risk in already fire-prone areas but also in new territories, in particular peri-urban areas, that is to say in interfaces between rural and urban areas (WUI for Wildland Urban Interface).

The prevention of natural risks is the mission of the public authorities, in charge with the preservation of the public order. This mission includes to maintain the public safety and to protect the population against the natural risk. In France, this mission is based on a legal framework imposing prevention measures, which concerns all types of risks. Some of these measures are specific for some risks, as forest fire risk. The French legal framework concerning natural risks is recent: it dates back to the early 80s (since law of 13 July 1982) (Sanseverino-Godfrin, 2008a). Because of the youthfulness of this policy and in a society characterized by a strong risk aversion, the legal framework evolves, especially after disasters, which reveal its lack. So, the legal measures increase. The main concern of this policy, since the 90s, is to decrease the vulnerability of the population and goods (Sanseverino-Godfrin, 2008b). In a context of climate change that may increase the extreme events and so the natural forest fires, the question is to know whether the legal framework is relevant or it should keep on evolving. Many guides and reports containing guidelines for adaptation to the climate change have been published in several countries (e.g. France,

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Commissariat général au développement durable, 2011, Observatoire national sur les effets du réchauffement climatique, 2009; Spain, Oficina de cambio climatico espanol; Italy, National climate change adaptation research facility, 2009). The European Union also proposes adaptation measures to reduce vulnerability to climate change (2007, 2009a, 2009b). The IPCC publishes a special report for the policymakers to manage the risks of extreme events and disasters (2012). The "Protection against the forest fire after the summer 2003 fires" report (Perriez et al., 2003) pointed the lack of rules and emphasized the need to develop general frameworks linking several legal measures with the objective of improving prevention and mitigation. The same types of recommendations are published in the report "Climate change and extension of exposed zones to forest fires" (Chatry et al., 2010).

Considering all this information, the question is what the main legal measures are to be developed and to be implemented in the territories actually exposed to forest fire which could be more exposed to this risk and the territories which are not exposed for that moment but which could be exposed in the future.

We propose to present this problematic through Corsica, as case study. We first present brief issues about Corsica and its level of risk generated by wild fires. Then, we present the legal prevention measures that can be applied today and their relevance for the future and the need of a possible regulation evolution.

2. Corsica and the exposition to forest fire risks

2.1. A brief presentation of the Corsica territory

Corsica is an island in the Mediterranean Sea, with mountainous landscapes and highest peaks (Cinto 2700 m; Rotondo 2600 m). For example, the north-eastern Corsica called "*Alpine*" is composed by peaks over 1000 m, a rugged relief, very close to the littoral area. Because of this rugged topography, road communications are difficult and it takes time to move through the different parts of Corsica.

93% of the territory of the island is covered by vegetation (820,000 out of 878,000 ha), composed by forest (58%), heathland, scrub and woodland (36%) (Inventory of the IFN - National Forest Inventory, 2014). That is why Corsica is the most wooded islands in the Mediterranean, from the littoral zones to the mountain peaks (Fig. 1).

Corsica is so an island few populated. However, the population in the island is increasing, according to the French Institute of Statistics (INSEE). The rate of evolution was +0.9% from 1982 to 2011 and +1.3% from 2006 to 2011. In 2011, the inhabitants of the island were 314,486 people; 322,120 people in 2013 and 323,092 in 2014, with a last rate of growth around of 1%. This rate of population growth is one of the highest rates in France. But comparatively to its size, the island is sparsely populated and urban development in Corsica is characterized by a low proportion of urbanized area (about 7% of the island). Moreover, the distribution of the inhabitants in the island is not homogeneous. There is a high concentration in the coastal areas (90% of 57000 units built, concentrated in 90% of the littoral municipalities) and a scattered urbanisation, in the remaining part of the territory (INSEE). The scattered urbanisation is one of the factors of vulnerability to forest fires.

2.2. Problematic of climate change and forest fire risk in Corsica

The study of the historical data concerning the temperature shows an increase of 1 °C since 1950. Between 1971 and 2010, the average annual air temperature in Bastia and Ajaccio increased by 1.5 °C. If this increase in temperatures continues, the average temperature in 2050 will be 17.5 °C in Bastia and 16 °C in Bastia, values that are characteristic of the climate of Tunis (Tunisia) and Cagliari (Sicily). The climate change and the increase in temperature have already had an impact on the rivers. Since 1985 a deficit of this Tavignano River has been measured, during 13 years out of 18 years. Period of low water in Corsica Rivers now lasts 5 months. It lasted 3 months in 1984. Simultaneously, a decrease in annual rainfall has been observed since 1985 (however, the autumn rains are more important, causing a risk of flooding). The drying up of mountain lakes has become structural rather than cyclical (Conseil Economique, Social et Culturel de Corse, 2013).

The projections elaborated by DRIAS[1] show an increase in heat waves. In 2035, heat waves could occur during 5 consecutive days. In 2080, according to the scenarios of the IPCC, these heat waves could last 10–40 days, depending on the areas of Corsica. The projections of DRIAS concerning the increase in temperatures show that there would be the anomalies average temperatures in summer (from +1.5 °C to 2 °C in 2035, from +4.5 °C to 6.5 °C in 2080, according to the different scenarios of the IPCC) and in winter (from +0.5 °C to 1 °C in 2035, from +1.5 °C to +3 °C in 2080, according to the different scenarios of the IPCC). The number of nights with a temperature above 20 °C ("tropical" night) would be 30–65 days in 2035 and 80–85 days in 2080.

Regarding rainfall in the Mediterranean area for 2050 different models converge to a decrease in rainfall, from 4% to 27%. On the contrary, in the year 2035, a slight increase of the rainfall in mountain areas would occur, but in a context of disturbed hydrological cycle: rainfall would occur in warmer climatic conditions with higher temperatures and increased evaporation (Conseil Economique, Social et Culturel de Corse, 2013).

One of the consequences of climate change is an evolution of the vegetation. As Garbolino et al. (2016) show, at the end of the twenty-first century, in Corsica, the plants will generally shift in altitude over a distance of 260 m, which correspond to an altitudinal progression of more or less 26 m every ten years. The colonization of the xeric and thermophilic plants in other parts of the territory than those they currently inhabit, especially in higher altitudes is a consequence of the increase of temperature. A significant 15% turnover of vegetation composition was measured in 10 years, leading to a sharp increase in xerophitic plants gaining ground against less drought-resistant ones. Moreover, another consequence of the climate change on vegetation is an increasing dieback of vegetation.

The climate change could have two impacts on forest fire risk. First, the increase of temperature, the extreme events and the decrease of rainfall accentuate the sensitivity of the vegetation to the flammability and combustibility, two important parameters to take in account for the fire risk (Ganteaume et al., 2009, 2012). Indeed, fires occur preferentially in situations of droughts and heatwaves because they are associated with low humidity both in soil and in the atmosphere and high temperature. Droughts are caused by a significant deficit of precipitation (especially in spring). They precondition summer heatwaves in Europe. They affect the vegetation phenological cycle and can modulate the amplitude of temperature anomalies during summer heatwaves (Stéfanon et al., 2012). Secondly, considering the evolution of vegetation, the areas exposed to forest fires should be even greater at the end of the 21st century and they should be extended more in altitude.

Concerning Corsica, if these forecasts are observed in the future, the areas exposed to forest fires should be even more important at the end of the XXI° century and they should be extended more in

[1] DRIAS, the future of the climate, climatic projections for the adaptation of our societies – drias-climat.fr.

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