The CypFire coordinator asked Prof. La Marca to present his research work. This case study must clearly indicate to the participant how to manage the urban-wildland interface areas, in relation to the fire risks which are the best methods to do it, which are the best measures to protect the periurban forestry, the settlements and the people life. The coordinator thanks the Authors for their contribution.

Urban Wildland Interface: a case study of the Tuscan Archipelago National Park (Italy)

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FOREWORD

Statistical of forest fires in Italian territory shows that the phenomenon of forest fires is one of the factors of greatest vulnerability of the territory (annex 1).

The Italian territory, except for urban areas, is characterized by a "broken landscape" (Sereni, 1955) in which settlements are often concentrated in small units or isolated buildings, alternating with wide cultivated fields and areas of natural vegetation (maquis, Mediterranean forests, etc.). According to the definition of the National Wildland/Urban Fire Protection Conference of 1987, these settlements and the related infrastructures are referred to as urban-wildland interface area. This interface-area has been expanding since the second post-war period due to the simultaneous increasing of forest surface by recolonization of abandoned cultivated land and centrifugal expansion of urban areas and tourist resorts (urban sprawl).

In the Mediterranean area, where summer forest fires are frequent and can have serious consequences, it is very important to manage the urban-wildland interface areas in order to ensure public safety and the protection of dwellings.

The authors present the results of a case study concerning the planning of the safety measures to be implemented in the urban-wildland interface area of the Tuscan archipelago National Park.

URBAN-WILDLAND INTERFACE: THE METHODOLOGY APPLIED FOR THE CASE STUDY OF THE TUSCAN ARCHIPELAGO NATIONAL PARK

The Tuscan Archipelago National Park (hereinafter referred to as the Park) is located in the Tyrrhenian Sea, between the Italian coast and Corsica (Figure 1).

Figure 1 – Geographical position of the Tuscan Archipelago National Park

Way before the establishment of the National Park (1996) its territory and sourrounding areas were heavily anthropized by widespread private housing (summer homes for non-residents, private homes of residents following the increase of population and tourism demand) and by expanding tourist facilities (hotels, restaurants, tourist villages, camping sites, etc.). On the only Island of Elba, the largest of the seven islands of the Tuscan Archipelago, the population living in the spring-summer months trebles compared to the rest of the year, from approximately 30,000 to approximately 90,000 people.

The chaotic increase of buildings, which has been restricted after the institution of the Park, represented and continues to represents an important vulnerability factor for all islands of the Tuscan

Archipelago. On the basis of the existing land-use planning tools new constructions are not allowed within less than 100 metres from the edge of forest areas and for other existing environmental constraint policies on approximately 50% of the Park surface (Picture 1,2,3,4).

The main fire characteristics of the territory of the Park are summarized in the Table 1.

Park surface ca. ha 17,800	
Park forest-covered surface ca. ha 4,275	Average values 1994-2008
No. of fires per year	5
Total annual burnt surface (ha)	134
Surface of individual fire (ha)	26
Forest annual burnt surface (ha)	125
Non-forest annual burnt surface (ha)	9

Table 1 – Data from the State Forestry Department referring to the 1994-2008 period in the Tuscan Archipelago National Park territory, (after Park Forest-fire protection Plan, under approval)

During 15 years (1994-2008) almost half of the Archipelago forests were destroyed by forest fires.

Despite the efficacy and good organization of the active forest fire fighting service a high mean surface was burnt by each fire.

This is a consequence of a number of characteristics of the Archipelago territory that are due to the typical Mediterranean climate, characterized by an extended period of summer drought associated with high average temperatures, by a vegetation often consisting in evergreen sclerophyllous shrubs with dehydrated tisssues during the fire period and due to the extended surfaces of artificial Mediterranean pine stands These reforested areas occupy over 1,100 ha of the Park territory, accounting for 26% of the natural vegetation and, are left without selvicultural management, because of the unfavourable market conditions. Most plantations show still the original stand density, reduced only by natural causes and fires.

As a consequence, the stability of the stands is compromised and phytosanitarian problems arise, destabilizing the forest ecosystem. This implies problems both with fire prevention and extinction. The magnitude of the problem is documented by the fact that during 15 years over 100 ha of the reforested surface was burnt, which is almost the totality of the artificial forest surface.

Picture 1 – Burnt reforested stands on Monte Calamita in 1985

Picture 2 – Reforestation of pines in the oriental part of the Isle

Hence, housing proliferation linked to mass tourism is also part of the explosive context of the fire phenomenon in the Park. But the problems are not only tied to the brick industry. In the Park territory there are other critical elements such as the camping areas that are particularly numerous on the Island of Elba (see picture 3-8 for different situation of urban-wildland interface).

Picture 3

Picture 4

Picture 5

Picture 6

Picture 7

Picture 8

RESULTS AND DISCUSSION

Data from the urban shape, taken from the 10,000-ratio regional technical map (CTR) by the Tuscany Region show that in the Park territory 222 areas are classified as camping sites or tourist villages equal to an average of 1,2 per square metre.

In the summer period these facilities host a great number of people who risk, in the case of fire, to be trapped in the forest flames: The Island of Elba is not new to such tragic events, big fires took place in 1985 and 2003.

When projecting Forest Fire-Protection (AIB) Plan of the Park it is extremely important to define the urban-wildland interface areas of the islands. Even if specific regulations concerning these areas are still lacking - the legislative void is probably due also to the variety of situations which characterize this interface

area (public forest-private home, forest owned by one person-home owned by another person etc.) - the Italian Ministry for the Environment included a definition of the interface areas and a number of appropriate management instructions in the guidelines for drawing up the AIB Plan of National Parks.

With this aim the urban-wildland interface area of the Tuscan Archipelago National Park was mapped.

For the definition of the dimension and methods of management of this area two sets of parameters were taken into consideration:

- the existing building types
- the "static" fire risk attributable to the territory within which the interface area falls.

This was done by using the Q-Gis *open source software* for spatial analysis, interfaced with Grass. Around the buildings buffer zones were defined with three different ranges of perimeter: 150, 200 and 220 m. It was established that the inner 10 m of these buffer zones had to be kept completely free from any vegetation. The types of building were identified and mapped according to their necessity of protection, according to table 2.

	Type of building	Radius of the ranges of protection (m)
Maximum	-school, hospital, religious, social buildings, -camping sites, tourist villages and hospitality facilities -power stations -fuel stations.	220
High	-civil dwellings, -office facilities, -buildings under construction, -greenhouses, stables, barns or farms, -cemeteries.	150
Minimum	dumps, scrap dealers and quarries	100

Table 2 - Dimensions of the "Ranges of protection" based on the types of building

The map obtained represents an early indication and the starting point for the classification of the territory according to the risk degree and for carrying out vulnerability analyses.

For the buffer zones risk assessment was defined taking into consideration a set of variables. First of all of the various vegetation types present in the buffer zones were classified in order to identify sub-areas as homogenous as possible (Foggi et al. 2006)

To this aim the phyto-sociological maps elaborated by the Department of Vegetable Biology of Florence University were used. The different types of vegetation were classified according to the fuel models suggested by Zerbini M. (2004) for the NFFL models, and by the Inter-university Research Centre "Biodiversity, Phytosociology and Ecology of the Landscape" (website of the Ministry for the Environment), then gathered in 5 partial risk classes, to which weights from 1 to 5 were assigned, based on the different degree of flammability. For risk definition the homogeneous vegetation sub-areas were subjected to a comparative analysis considering the following factors:

- Inclination: Five degree classes were considered (0°-8°,9°-10°,11°-15°,16°-22°, >22°). The estimate was made by using a 25 m-pitch DEM.
- Side exposure: Five directions were considered (North, East, South, West and Zenith). Here, too, the estimate was made by using a 25 m pitch DEM.
- Phytoclimate: Three classes of phytoclimate were considered.
- Distance from the roads: This element was introduced to keep also account of the anthropic aspect of fire risk definition. Analyses carried out during the redaction of the A.I.B. Plan, using the data concerning the points of fire ignition supplied by the National Forest Service and then processed in GIS environment, showed a close relationship between distance from the road and the ignition points. Each class of distance was then assigned to one of the five classes of risk. The results of this analysis are reported in table 3.

Classes of Distance from the roads (m)	Total road network		Provincial Roads		Risk degree
	[N.]	[%]	[N.]	[%]	
≤ 100	98	61	55	45	5
101÷250	41	25	29	24	4
251÷400	16	10	21	17	3
401÷550	5	3	9	7	2
>550	1	1	7	6	1

Table 3 – Number and percentage of fire ignition points based on the distance from the road network. Each class of distance was assigned to one of the five classes of risk

Thus thematic layers were produced and then superimposed by means of spatial analysis operations and arithmetic operations on attributes, allowing to draw a map which is the result of the weighted addition of the various factors. The data thus obtained were grouped in four classes of risk (Low, Average, High, Very High) to build the map of risk within the interface area.

This map contains the silvicultural activities (thinnings) to be implemented within each range of protection (Table 4).

Ranges of protection (m)	*Thinning intensity (in %) within the ranges of risk*		
	Low	*Average*	*High*
≤10			
10 < L < 220	*25*	*30*	*45*

Table 4 – Thinnings intensity (in %) to be implemented in the ranges of protection based on the range of risk.

The maps (in PDF format) are available on the website of the Tuscan Archipelago National Park; an excerpt is found below.

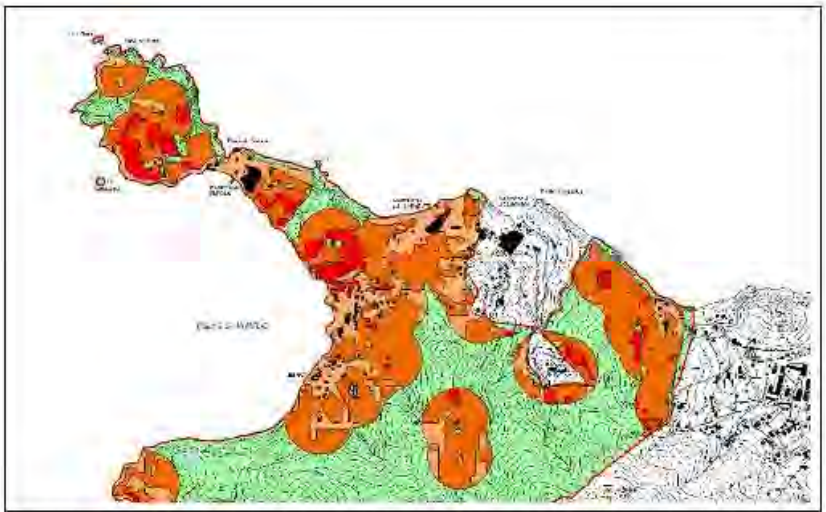

Figure 2 – Detail of the urban-wildland interface map of the Island of Elba. Green is the area falling inside the Park perimeter. Red is the interface area falling in high-risk areas, brown is medium risk and beige low risk.

The awareness of the fire problem in the interface areas led to the analysis of the technical feasibility of the necessary safety measures.

The total surface for protection measures within the Tuscan Archipelago National Park is summarized in Table 5.

Risk Class	SURFACE of the interface area within the 220 m range (ha)	SURFACE of the interface area within the 220 m range (%)	SURFACE of the interface area within the 10 m range (ha)	SURFACE of the interface area in the Park territory (%)
Low	103,144	23	2,13	5
Medium	2612,23	59	5.4	13
High	809,97	18	1.67	4
Total	4453,64		9.2	23

Table 5 – Classification of the surface occupied by the total interface area (220 m radius) and by the inner area (10 m radius) based on the ranges of risk. The fourth column shows the percentage of interface area within the Park surface .

CONCLUSIONS

The urban-wildland interface area makes up 23% of the total Park territory and slightly more than 9 ha are covered by the 10 m radius protection range from dwellings which has to be transformed into meadow physiognomy.

In conclusion this means that regular thinning operations on over 20 % of the Park surface should be carried out.

Even in the case of full acceptance of the owners (public and private) of the areas that fall in the buffer zones corresponding to the interface areas, the thinning operations require an organization of forest enterprises which is not always available, considerable economic resources and the solution of a number of problems resulting from the constraints of the areas that are part of the Natura 2000 network. Finally, there is the issue concerning the destination of the logging material from the interface areas.

From market surveys it emerged that at least 30% of these costs could be recovered if a market outlet was found for the material from the thinning operations in the Archipelago forests. As the images clearly show that this wood material is not precious, but that in any case it could be employed as fuel to power small local biomass power stations. Hence, it would be the case to create a short forest-wood-energy chain that would bring several benefits: healthier, usable and protected forests, local employment, clean and low-cost energy.

Where the buildings are in clusters of different sizes (high tourist development areas, ancient rural villages), the application of such fire-protection ranges as described for the interface area would have little or no tolerable impact on the vegetation.

In these cases, we suggest to consider the entire cluster, or to adequately split the settlements into basic clusters made up of multiple buildings, and apply to each basic cluster the ranges of protection that include meadow use for a 10 m radius around each dwelling and a 110 – 220 m buffer area around each basic cluster, according to the chart shown in the following image (Figure 2).

Figure 2 – The red line is the inside area to manage with a thinning of very low intensity. The blue line area is Outside the homes perimeter to manage with decreasing-intensity thinning

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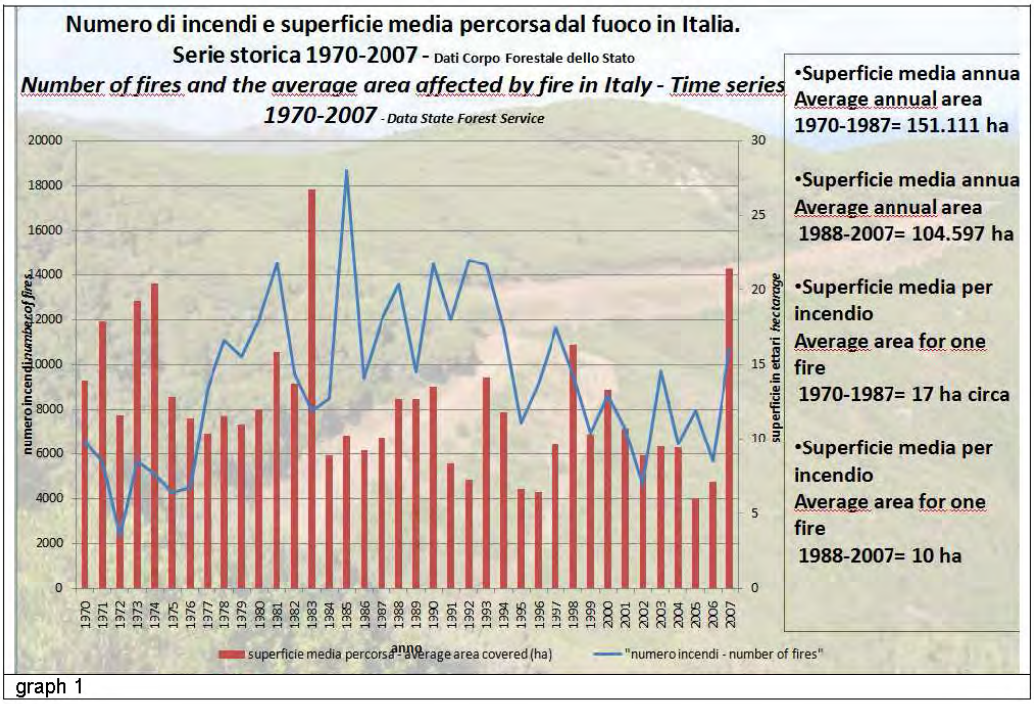
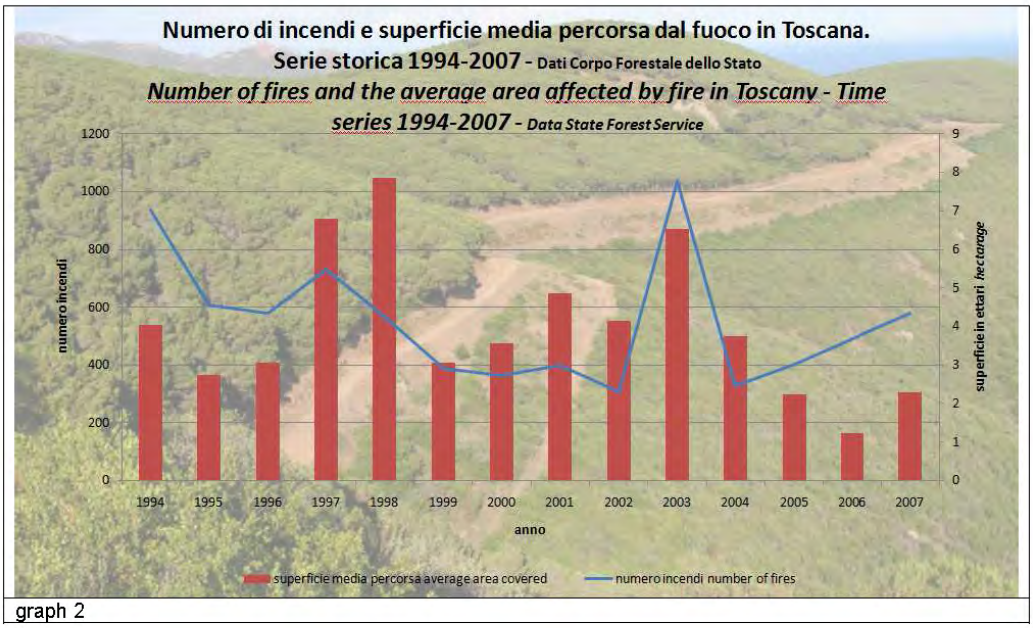
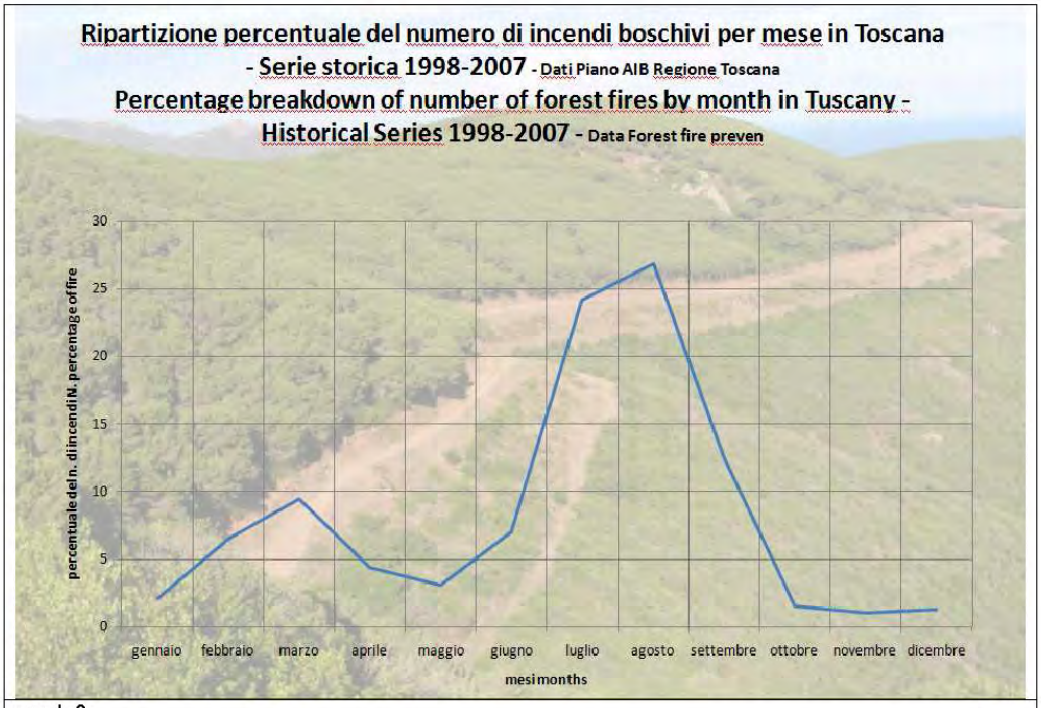
Annex 1: *Statistical Work of forest fires in Italy and Tuscany*



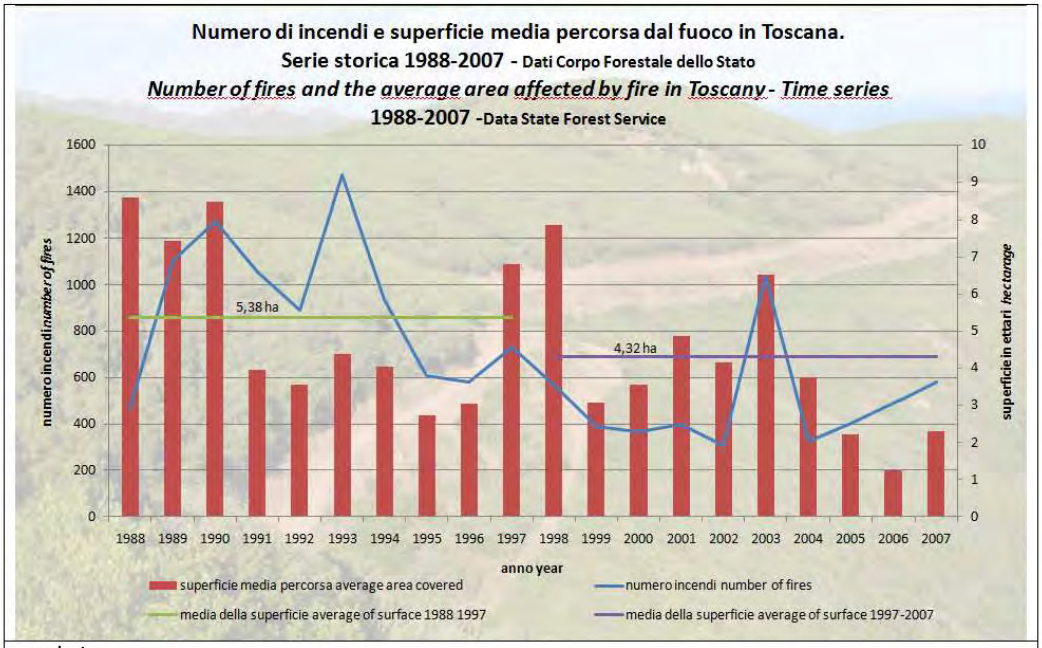
graph 1



graph 2



graph 3



graph 4


Confronto tra superfici medie percorse dal fuoco: in Italia e in Toscana
Serie storica 1988-2007 - Dati Piano AIB Regione Toscana
Comparison of average areas covered by fire: in Italy and Tuscany
Time series 1988-2007 - Data Forest fire prevention plan
superficie media percorsa average area covered (ha)
25
20
15
10
5
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
anno year
superficie media percorsa in Italia average area covered in Italy
superficie media percorsa in Toscana average area covered in Toscany

graph 5