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ANALYSIS OF FUEL TYPE AND VEGETATION STRUCTURE FOR FIRE RISK INDEX DEVELOPMENT

Grazia Pellizzaro*[1], Carla Cesaraccio[1], Corrado Asunis[2], Claudio Caria[2]
[1]CNR – IBIMET, Institute of Biometeorology, Agroecosystem Monitoring Lab., Sassari, Italy
[2]DESA, University of Sassari, Sassari, Italy

1. INTRODUCTION

Evergreen sclerophyll shrubland is a prominent feature of Mediterranean Basin. The combination of dense fuels, summer drought, dry summer winds, and anthropic activities contributes to increase fire risk in Mediterranean ecosystems (Rambal and Hoff, 1998). In this context, the development of fire risk indices related to different plant species is important in preventing forest fires (Fernandes, 2001; Castro et al., 2003). Indices which include statical and dynamic variables are called integrated or advanced. Using variables from different experimental sites located in North Sardinia, Italy, an integrated forest fire index (IFI) was developed to be included into an operational warning system managed by the Regional Weather Service of Sardinia, Italy (see the companion paper submitted by Spano et al. 5th Symposium on Fire and Forest Meteorology).

The IFI index is based on (1) parameters describing the water status of vegetation, (2) parameters related to fuel type and vegetation structure, (3) micrometeorological or meteorological parameters and (4) topological parameters which describe site topography and prevailing synoptical conditions.

Vegetation description and characteristics of the dominant species in the community are important parameters because they are crucial for vegetation flammability and fire spread (Vilà et al., 2001)

In this paper, preliminary results on fuel type analysis and vegetation structure are presented.

2. MATERIALS AND METHODS

The study was conducted in two Mediterranean type ecosystems. The first was in a coastal area and the second in an inland hilly site, both dominated by evergreen and semi-deciduous small shrub species. The first site is located in North-Western Sardinia, Italy, within a nature reserve (40° 37’ N, 8° 10’ E, 40 m a.s.l.) covering approximately 1200 ha. The soils are Luvi and Litosoils. The climate is semi-arid with a remarkable water deficit from May through September (mean annual rainfall 640 mm, mean annual temperature value 16.8 °C). The second site is located in North-Eastern Sardinia, Italy, in a forest area (40° 43’ N, 9° 24’ E, 700 m a.s.l.) extended for approximately 2400 ha. The soils are Lithic Xerorthenes. Rainfall are concentrated in autumn-winter season with a water deficit from May through August (mean annual rainfall 996 mm, mean annual temperature value 12.9 °C).

In the coastal experimental area, within a 12 ha macro plot, 104 quadrats (12 m^2 each one), placed at 30 m intervals along 13 transects, were selected and sampled. In the inland area two 15 m x 15 m quadrats were selected and each quadrat was divided in 25 subareas. In each quadrat, number of species, height of plants, and canopy diameters were measured. Species composition, mean height and diameter of small shrubs (h<1 m), tall shrubs (1<h<2 m), and small trees (h>2 m), specific ground cover, and biomass were determined. Biomass, sorted by height class, was estimated starting from destructive measurements. In addition, the annual pattern of leaf moisture content on fresh weight was measured on the dominant species in each site.

3. RESULTS

The two Mediterranean shrubland areas showed differences in the specific composition and vegetation structure and height.

The inland site represented a highly disturbed ecosystem degradated by frequent and intense fire events whereas the coastal area was an example of regenerating vegetation

*Corresponding author address: Grazia Pellizzaro, CNR-IBIMET, Institute of Biometeorology, Agroecosystem Monitoring Lab., Via Funtana di Lu Colbu 4/A, 07100 Sassari, ITALY; e-mail: G.Pellizzaro@ibimet.cnr.it

without disturbs after a fire event occurred thirty years ago.

In the coastal area the vegetation was mainly characterized by plants with height lower than 1 m (Figure 1). In this height class the dominant species were *Chamaerops humilis* (27%) and *Cistus monspeliensis* (28%) for specific composition, and *Pistacia lentiscus* (33%) for plant cover (Table 1). The average height and diameter of all species were respectively 0.50 m and 0.42 m. In terms of biomass, the most important species was *Genista acanthoclada* followed by *Pistacia lentiscus*. During the driest month the percentage of moisture content ranged between 31% for *Genista* and 38% for *Rosmarinus officinalis*. Vegetation with height between 1 and 2 m represented 38% of plant cover (Figure 1). The main species in terms of plant cover were *Juniperus phoenicea* and *Pistacia lentiscus* (Table 2). The average height and canopy diameter were equal respectively to 1.31 m and 1.08 m. Again, *Genista acanthoclada* was the main species in determining the total biomass dry weight. Within small tree class (h > 2 m), *Juniperus phoenicea* was the dominant species with an average height of 2.56 m and an average canopy diameter of 1.85 m.

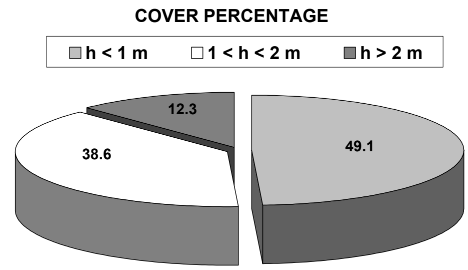
Table 1 – Species composition (SC), cover percentage (C), mean height (h), mean diameter (d), biomass (B), and leaf moisture content (M) in the coastal area for height class h<1 m.

Species	SC (%)	C (%)	h (m)	d (m)	B (t/ha)	M (%)
Phillyrea angustifolia	2.23	2.03	0.53	0.37		31.5
Stachys glutinosa	2.85	1.65	0.22	0.25		
Juniperus phoenicea	3.88	3.35	0.58	0.39		34.9
Rosmarinus officinalis	6.28	8.84	0.58	0.52	0.53	38.3
Genista acanthoclada	7.35	15.78	0.72	0.66	10.06	31.0
Pistacia lentiscus	12.38	33.22	0.63	0.73	5.60	34.5
Chamaerops humilis	27.31	14.88	0.51	0.34	0.59	35.3
Cistus monspeliensis	28.37	16.82	0.43	0.35	0.13	36.7
Other species	9.31	3.43	0.44			

Table 2 – Species composition (SC), cover percentage (C), mean height (h), mean diameter (d), biomass (B), and leaf moisture content (M) in the coastal area for height class 1<h<2 m.

Species	SC (%)	C (%)	h (m)	d (m)	B (t/ha)	M (%)
Rosmarinus officinalis	18.26	19.46	1.25	1.12	1.37	38.3
Pistacia lentiscus	19.76	23.23	1.27	1.20	4.83	34.5
Juniperus phoenicea	20.66	27.90	1.55	1.23		34.9
Genista acanthoclada	26.35	21.98	1.27	1.04	9.67	31.0
Other species	14.97	7.43	1.17			

In the inland site the vegetation cover mainly included species with height lower than 1 m, and the prevailing species were *Cistus* spp. and *Lavandula stoechas* (Figure 1).



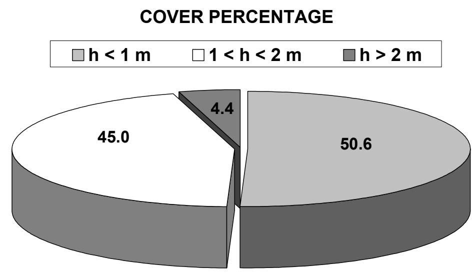


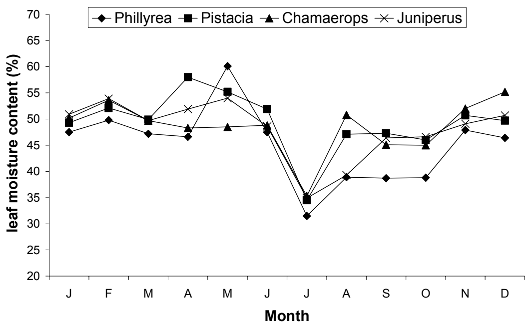
Figure 1 – Cover percentage for dominant species in the coastal area (upper graph) and in the inland site (lower graph).

Table 3 – Species composition (SC), cover percentage (C), mean height (h), mean diameter (d), and leaf moisture content (M) in the inland site for height class h<1 m.

Species	SC (%)	C (%)	h (m)	d (m)	M (%)
Erica scoparia	12.84	32.83	0.60	0.56	24.3
Lavandula stoechas	36.85	25.08	0.39	0.33	
Cistus spp.	43.44	29.55	0.40	0.32	28.2
other species	6.86	12.53	0.60		

Table 4 – Species composition (SC), cover percentage (C), mean height (h), mean diameter (d), and leaf moisture content (M) in the inland site for height class 1<h<2 m.

Species	SC (%)	C (%)	h (m)	d (m)	M (%)
Phillyrea angustifolia	7.07	6.45	1.17	1.36	33.6
Arbutus unedo	8.08	12.10	1.50	1.54	42.6
Erica scoparia	65.66	70.72	1.26	1.43	24.3
other species	19.19	10.73	1.51		



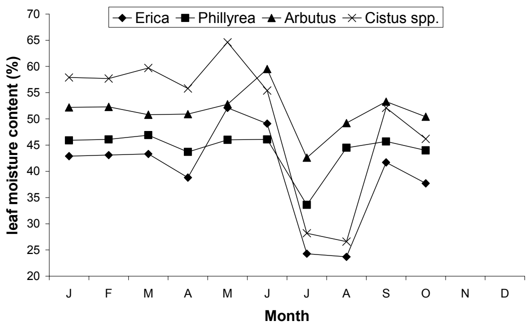


Figure 2 - Annual pattern of leaf moisture content on fresh weight for dominant species in the coastal area (upper graph) and in the inland site (lower graph).

The average height for this class was 0.44 m, and the average diameter was equal to 0.37 m. The percentage of leaf moisture content value was about 26% (Table 3). In the vegetation layer with height between 1 and 2 m (45% of plant cover), *Erica scoparia* was the dominant species in terms of percentage cover and species composition (Table 4). The average height for this class was 1.32 m and the average diameter was 1.38 m. Vegetation higher than 2 m represented only 4% of plant cover and it was constituted by few trees of exotic species which were introduced by anthropic activities.
The annual pattern of leaf moisture content for dominant species is shown in Figure 2.

4. CONCLUSIONS

In this work site specific basic descriptors of stand structure, annual pattern of live fuel moisture, and, for the coastal area, fuel weight of dominant shrub species were determined in two representative ecosystems of Mediterranean maquis.

The results were used as input values in the IFI index and they can be also used to increase the accuracy of fire forecast when others fire risk models are used.

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