P4.7 SHRUBLAND ECOSYSTEMS IN EUROPE UNDER CLIMATIC CHANGES: PRELIMINARY RESULTS FROM A MEDITERRANEAN-TYPE ECOSYSTEM

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1. INTRODUCTION

Elevated temperatures and extended droughts are predicted to have a large influence on the functioning of natural and semi-natural environments both directly and through interactions with land management and pollutant loading (IPCC, 1990). Climatic changes may have particular strong effects on vulnerable ecosystems, which are already subjected to other stresses such as elevated N deposition, intensive grazing or the risk of fire (Sala et al., 1998).

VULCAN - *Vulnerability assessment of shrubland ecosystems in Europe under climatic change* (see the companion paper P4.1 submitted by Beier et al.) - is a European research project conducted in Denmark, United Kingdom, the Netherlands, Spain, Italy, and Hungary investigating the effects of climate change on the functioning of six shrubland ecosystems along a temperature, moisture and N-deposition gradient. Experimental manipulation of the climatic conditions at field scale is conducted employing a newly developed "night-time warming" technique and an automated covering system to extend summer drought (Beier et al., 2000). In this paper the experimental site located in Sardinia, Italy, is presented and preliminary results on climatic manipulation (warming and drought) are reported.

2. MATERIALS AND METHODS

The Italian site is located in the Peninsula of Capo Caccia (north-western Sardinia), within the Nature Reserve named “Porto Conte” (40° 37’ N, 8° 10’ E). The Nature Reserve covers approximately 1200 ha between the coast line and a 360 m tall hill. In the area four different vegetation types can be easily identified: a quite recent forestation area of Pine, the Mediterranean macchia, a *Quercus ilex* forest and the garigue, located near the coast and dominated by small bushes and tiny herbaceous plants growing between emerging rocks. The most frequent geologic substrate of the area is represented by Mesozoic rocks with calcareous outcrops with dolomites. The most common soils are Luvi and Litosoils, neutral, with depth hardly exceeding 20-30 cm. The climate is semi-arid with a remarkable water deficit from May through September and a mean annual rainfall amount of 640 mm. The mean annual temperature value is 16.8 °C. Maximum and minimum air temperatures result milder due to sea vicinity (10 °C in January and 24 °C in August). Even winter season can be dry and temperature not so low to determine vegetation break.

The experimental plots are located in a firebreak strip constructed in 1973 and cleared by fire until 1990. In 1991 and 1992, the firebreak strip was cleared mechanically and from 1993 a natural recolonization process started. The plots are covered with vegetation of a maximum height of 1.0 m including sclerophyll species (*Cistus monspeliensis*, *Dorycnium pentaphyllum* and *Helichrysum italicum*), some scattered shrubs (*Pistacia lentiscus*, *Cistus incanus*, *Daphne gnidium*, etc.) and several herbaceous plants (*Carlina* spp., *Asphodelus* spp., *Brachipodium ramosus*, *Ammoides pusilla*, etc.). Vegetation covers about 80% of the plot surface.

The set-up of the experimental site was completed on summer 2001. The 20-m^2 plots were manipulated by night-time warming and extending summer drought and the response to the treatments were compared to control plots. Each type of manipulation was replicated 3 times.

The warming treatment was created covering the vegetation with an automated 1.5-m-tall aluminum curtain at night. This method determines very little disturbance in comparison with other field scale methods for manipulating air and soil temperature in terrestrial ecosystems.

In the drought treatment the curtain material is transparent to infrared radiation and the movement of the curtains are determined by rainfall events. The drought treatment was carried out for a 3-month period in autumn 2001.

A micrometeorological monitoring station equipped with 69 sensors (rainfall, wind speed and direction, radiation, air and soil temperature, relative humidity, soil water content) was installed to obtain data from each plot on the microclimatic changes determined by the treatments.

Since changes in plant growth and processes are fundamental for the assessment of vulnerability and sensibility of shrubland ecosystems to climate change, the response of the plants to the treatments were monitored measuring plant cover, growth, phenology,

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leaf gas exchange, plant chemistry, litterfall, and litter quality. The frequency of measurements was different for each variables ranging from weekly (phenology) to yearly (growth). Pre-treatment measurements were done to identify variability between areas or plots.

Soil processes are expected to be sensitive to climate change mainly due to biotic response to changes in temperature and water availability affecting decomposition rates. An experiment on decomposition rates of litter started in July 2001, using the litterbag technique and collecting fallen leaves of the dominant species. In addition, daily course measurements of soil and root respiration were made every two months using an infrared gas analyzer.

Changes in water chemistry (precipitation, throughfall and soil water) are often the most sensitive component of an ecosystem to environmental perturbations and can be an useful indicator of changes in important processes at an early stage. A monitoring program for soil water chemistry will be implemented during the second year of activities sampling bulk precipitation and installing an automated soil water sampling system.

3. PRELIMINARY RESULTS

VULCAN manipulations at the Sardinia site have been running since August 2001 and the results obtained during the first year of activities are limited and preliminary. However, some results on the climatic manipulation can be shown.

The warming effect on air and soil temperature was variable depending on weather conditions, as shown in Figure 1. The warming treatment resulted in an average increase of the minimum daily temperature of about 1-2 °C both for soil and air.

Drought treatment was applied from early September to the end of October. During that period rainfall was equal to 237 mm, approximately 40% of the annual input. In Figure 2 the effect of the drought treatment on soil water content (expressed as percentage of the maximum annual value) is shown.

4. CONCLUSIONS

The experimental climatic manipulation at the VULCAN Project site located in Sardinia was successfully conducted during the first year of activities. Both the passive night-time warming technology and the drought cover simulate real changes in climate conditions better than other techniques and they minimize disturbances on soil and vegetation. Further years of treatments are needed to determine potential effects of climatic manipulation on ecosystem functioning.

5. REFERENCES

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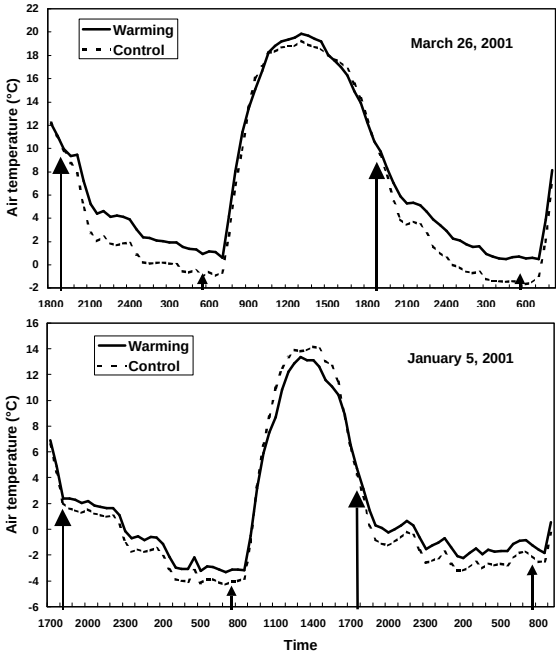

Figure 1. Effect of the warming treatment on the air temperature (0.25 m above ground) on March 26 (clear sky day) and January 5 (cloudy day), 2001, at Porto Conte site. The arrows indicate the beginning and the end of the night-time warming.

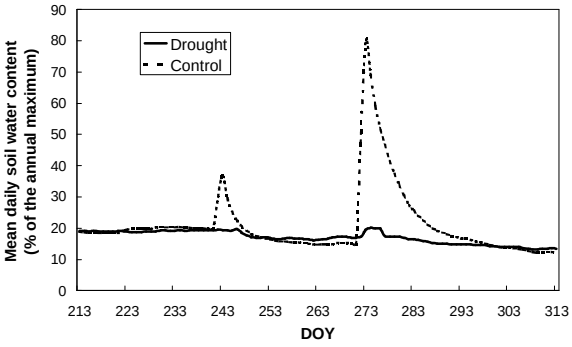

Figure 2. Effect of the drought treatment on the soil water content during two rainfall events occurred at the end of August and at the end of September 2001 at Porto Conte site. Soil moisture measurements were made using dielectric probes (Echo, Decagon Devices, USA).

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