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Changes in Alpine grassland of Gran Paradiso National Park (Italy): first results from CO_2 fluxes monitoring programme.

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Abstract

The alpine grassland of Gran Paradiso National Park (Italy) resulted from centuries of human activities that created high biodiversity semi-natural areas below the timberline. The progressive abandonment of management practices as well as climate change lead to variations in species diversity. In order to apply active management actions for maintaining such ecosystem, a long-term monitoring programme started in 2016 in selected sites of the Park, aimed to: 1) evaluate the effects of a well managed grazing system on animal and plant biodiversity; 2) compare the evolution of managed and non-managed areas, the latter obtained by excluding a portion of the meadows from grazing. Together with CO_2 fluxes, monitoring includes also plant community, invertebrates, soil properties. We present the first results of spatial and temporal variability of CO_2 fluxes from grasslands in relation to air temperature, radiance and soil properties.

Keywords

alpine grassland; Gran Paradiso National Park, CO2 fluxes; Ecopotential

Introduction and Research questions

The Gran Paradiso National Park (GPNP), in the western Italian Alps, is the oldest National Park in Italy. It shows significant high-altitude environments, and hosts the original surviving population of Alpine ibex (Capra ibex).

The open areas of GPNP result from centuries of human activities that determined a lowering of the treeline ecotone, creating peculiar semi-natural areas below the timberline, characterized by high biodiversity values.

The progressive abandonment of mowing and grazing from high-elevation mountain areas is modifying species composition and richness (TASSER & TAPPEINER 2002) that can affect its forage value for mountain wild herbivores (PAROLO et al. 2011). Moreover, fragmentation due to increase of woodlands may negatively influence the interchange of grassland species (BERLIN et al. 2000). Abandonment of traditional land management may also affect nitrogen plant concentration and mineralization (ZELLER et al. 2000), soil organic carbon fraction (GUIDI et al. 2014) and the net ecosystem CO_2 and CH_4 exchange (WOHLFAHRT et al. 2008; IMER et al. 2013).

Climate change is another risk factor for mountain grassland, leading to an upward shift of alpine plant species, with consequent community composition changes and local extinctions (WALTHER et al. 2005, DIRNBÖCK et al. 2003). In addition, increasing temperatures can lead to higher evapotranspiration rates (ABTEW & MELESSE 2012), with direct consequences on soil moisture and vegetation structure. The decline of soil water availability induces an increasing reduction of nutrient uptake and carbon assimilation with a consequent slowdown in plant growth (DALY et al. 2004). The reduction in snow cover alters the frequency of soil frost events and the dynamics of freeze-thaw cycles. This could influence a range of ecosystem properties, including rates of nutrient cycling and, hence, CO_2 (MERBOLD et al., 2013). Water and carbon fluxes between soil, vegetation and atmosphere are only partially known for mountain grasslands, also owing to the complex geological matrix, to the wide variations in soil depth and sub-soil characteristics, and to the unknown response of the fluxes to extreme impact events and climate variability. Particularly, net CO_2 flux from grassland varies largely in time scale (short and long-term) in response to many factors, such as meteorological drivers, changes in the ecosystem structure (including natural and anthropogenic disturbances like changes in land use and management) or physiological response to climate. All these modifications can seriously affect both traditional landscape and herbivores demographic parameters, in turn limiting the possibility of sustainable tourism, associated with the presence of populations of wild ungulates and pristine grassland conditions.

In the framework of the H2020 ECOPOTENTIAL project (www.ecopotential-project.eu), that focuses its activities on a targeted set of internationally recognized Protected Areas, we would like to evaluate the effects of anthropogenic and climate pressures in managed and non managed grasslands on animal and plant biodiversity.

In particular, a long-term monitoring program started in 2016 in selected sites of GPNP aimed to: 1) evaluate the effects of a well-managed grazing system on animal and plant biodiversity; 2) compare the evolution of managed and non-managed areas, the latter obtained by excluding a portion of the meadows from grazing.
In order to investigate short-term adjustment of the grasslands' CO_2 fluxes to climate variability and anthropogenic disturbances, long-term observations and monitoring have to be performed.

Research area and methods

GPNP is about 70,000 ha in size and it includes 5 main valleys. Three of these valleys, running North to South, originate from the northern slope of the Gran Paradiso massif (Aosta region), while two East-West oriented valleys originate from the southern slope (Piedmont region).

The selected sites are Noaschetta (In Piedmont) and Nivolet (in Aosta Region) valleys (Fig. 1). In Noaschetta, an extensive cattle pasture is the only local activity, together with high transit of hikers along trails. Acidophilus grassland of mountain and low subalpine level dominate the natural landscape, colonized by shrubs and trees in the last years. Here we selected two areas, Piangirot and Piansengio. In each of these areas, we selected an 'exclusion plot' where grazing activity is prevented (Fig. 2).

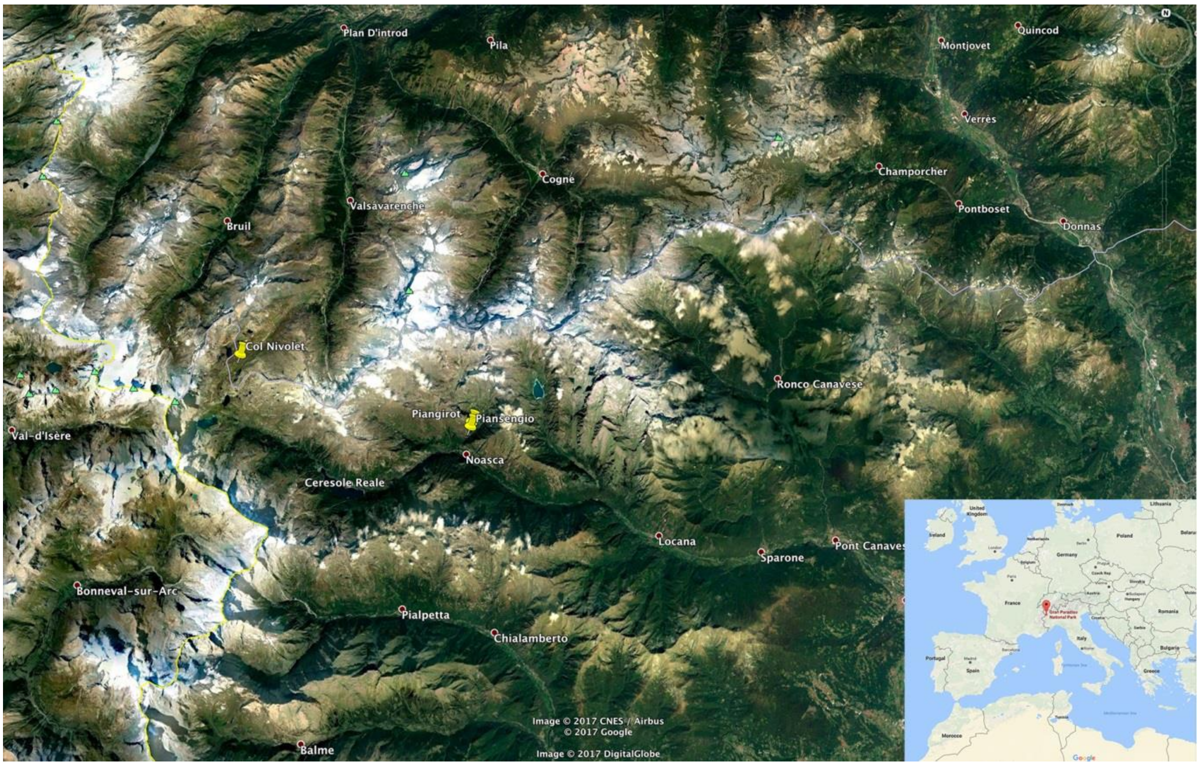

Figure 1: Gran Paradiso National Park.

Col Nivolet is a highly-protected, closed hydrological basin between about 2500 and 2700 meters asl. This area, covered with snow from November to June, is characterized by a complex environment of alpine pastures, oligotrophic lakes, peat bogs, rock outcrops and meandering streams. Here, we selected 4 plots on the main rock outcrops and environment: gneiss, carbonate, glacial deposit and alluvial soil.

Methods

The monitoring program includes plant community, invertebrates, soil properties and CO_2 fluxes .CO_2 fluxes are measured using the accumulation chamber method, composed by an automatic transparent accumulation chamber, diameter 215 mm, height 315 mm (Fig. 3), and equipped with 1) a CO_2 NDIR-sensor (LI-COR LI820), with the range 0-2% vol. and resolution 1 ppm; 2) Power supply unit, including a 14.4V, 4.5 Ah battery, and managed by a handheld computer (PDA) that allows geo-referencing and post processing of acquired data. We also measure soil temperature, soil electrical conductivity, soil relative humidity with a soil probe inserted for about 10 cm into the soil) as well as air pressure, Air temperature and radiance. In each selected area, we perform several CO_2 fluxes measurements with the transparent chamber (light condition) and in dark condition (with the chamber obscured). Soil samples were collected in order to analyze pH, conductivity, inorganic and organic carbon, total nitrogen.

Figure 2: Noaschetta Valley, GPNP: Grazing exclusion plot. Photo credits: Mariasilvia Giamberini.

Figure 3: Nivolet plain, GPNP: Flux chamber in use. Photo credits: Mariasilvia Giamberini.

Results and future perspectives

In summer 2016, CO_2 fluxes were measured in August in Piangirot and Piansengio sites. The net fluxes were about – 0.5 mol m-2 die-1 and in dark condition CO_2 fluxes were about +0.6 mol m-2 die-1. The pH of the soils collected in Noaschetta ranges from 4.1 to 5.8 with a conductivity ranging from 11 to 438 μS25°C/cm. The content of inorganic carbon of soils is under the detection limit, reflecting the absence of carbonate rocks in the catchment.
In summer 2017, several field measurements of CO_2 fluxes, radiance, temperature and humidity of soils are carried out in Noaschetta and in Col Nivolet in order to better describe temporal and spatial variability of CO_2 fluxes for alpine grassland in natural and well-managed grazing. Measures are planned to continue in the next 10 years at least.

Data collected will be elaborated with statistical analysis methods in order to correlate them with radiance, air and soil temperature, soil humidity, soil conductivity, vegetation cover and soil type.

Once a more complete data set will be acquired in the next years, we aim to provide a model that relates the grassland management practices to the state of the ecosystem, focusing on the effects of grazing on biodiversity, soil biogeochemistry and carbon cycle.

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