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A thematic vegetation dataset of SArdinian GRAsslands (SAGRA)*

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Abstract

We present the dataset "SArdinian GRAsslands" (SAGRA), a collection of georeferenced vegetation surveys sourced from different areas of Sardinia (Italy). SAGRA addresses a geographic gap in current databases, as plots from Sardinian grasslands are underrepresented. We collected vegetation data from different projects and organized it within a framework that allows for scalability to larger scales or integration into existing databases. The surveys include three categories of information: general, vegetation and management, and environmental. Overall, SAGRA comprises 1277 vegetation surveys, some of which were performed in different years in the same plots. This dataset encompasses 685 plots and 434 species, primarily therophytes.

This georeferenced vegetation dataset can support further scientific research and aid the sustainable management of Mediterranean grasslands.

Keywords

Databases, Grassland management, Mediterranean grasslands, Phytosociological surveys, Plant diversity, Vegetation data, Vegetation plots

Introduction

Large-scale databases offer valuable opportunities to monitor biodiversity across various spatial and temporal scales. Vegetation plots, compared to occurrence data are particularly effective for monitoring vegetation. They provide several advantages, including the identification of co-occurring and missing species (Phillips et al. 2009; Chytrý et al. 2016; Sabatini et al. 2021). Using vegetation plots in plant community ecology is a crucial breakthrough that significantly contributes to understanding distribution patterns and dynamics (Kapfer et al. 2017; Sabatini et al. 2021). Additionally, it helps address emerging issues such as the severe risk of species loss, habitat degradation, and biodiversity decline (Biurrun et al. 2021). Plots also play a key role in classifying vegetation, assessing the conservation status of species and habitats, and monitoring the spread of alien species (Chytrý et al. 2016; Yannelli et al. 2022; Janssen et al. 2023). Although vegetation plot data were historically collected within specific projects or survey campaigns tailored for local and regional objectives, the widespread harmonization and accessibility of

* Topical Collection: "Vegetation databases: enhancing data integration and accessibility for ecological research".

this resource started only a few decades ago (Schaminée et al. 2006). Currently, numerous initiatives have established vegetation databases on national, supranational, and global scales (Landucci et al. 2012; Chytrý et al. 2016; Bonari et al. 2019; Bruelheide et al. 2019; Sabatini et al. 2021; Alessi et al. 2022). Besides broad-scale initiatives, some databases focus on specific environments or habitats. For instance, the GrassPlot database concentrates on multi-scale plant diversity in Palaearctic grasslands (Dengler et al. 2018). Thematic databases, like GrassPlot, enhance monitoring effectiveness by providing additional details related to the management of surveyed areas. This is crucial for secondary grasslands, as their existence and floristic composition are strongly associated with specific management practices and grazing livestock (Klimek et al. 2007; Halada et al. 2011; Ribeiro et al. 2014; Perring et al. 2018; Janišová et al. 2021). Monitoring biodiversity vital for identifying trends and drivers of change, guiding policy formulation, sustainable management, and conservation actions. This is especially crucial in the face of a global crisis influenced by land use change and climate change (Lindenmayer and Likens 2009; Watson et al. 2019; Knollová et al. 2024). Moreover, georeferenced plots play a pivotal role in resampling vegetation at the exact locations over time. Therefore, databases with resampled and georeferenced plots are invaluable for consistent vegetation monitoring. Approximating the relocation of plots can potentially exaggerate temporal changes and compromise results (Kopecký and Macek 2015).

Among secondary formations, Mediterranean grasslands are of particular interest due to the biodiversity they host and the ecosystem services they provide, including nutrient cycling, carbon sequestration, water cycle regulation, agricultural goods, and cultural heritage (Unger and Jongen 2014; Ribeiro et al. 2014; Seddaiu et al. 2018; Grenke et al. 2022; Malavasi et al. 2023). However, these grasslands face challenges such as intensive grazing practices, grassland abandonment, and climate change (Dibari et al. 2021). This leads to a decline in surface area and grassland quality, thus posing a severe conservation issue (Klimek et al. 2007).

The availability of data on vegetation in Mediterranean pastures is crucial for implementing monitoring activities aimed at their management. In this context, our efforts have concentrated on a specific area in the Mediterranean region, Sardinia (Italy), whose territory has been shaped over the centuries by pastoral activities (Malavasi et al. 2023). Sardinia is recognized as a hotspot for plants in the Mediterranean region (Myers et al. 2000). The number of taxa reported for the island varies (Bagella et al. 2020a), with Arrigoni (2006–2015) citing 2810 taxa and Bartolucci et al. (2024) reporting 2479 taxa, considering only native and archeophytes. The island's diverse climate, topography, and geological substrates contribute to the variety of potential natural vegetation, primarily characterized by *Quercus ilex* and *Q. suber* woodlands (Bacchetta et al. 2009). These grasslands, which are of secondary origin, are a crucial component of agro-silvopastoral systems and currently face significant threats from abandonment (Seddaiu et al. 2018; Bagella et al. 2020b). To facilitate the utilization of available data, we have built the dataset "Sardinian Grasslands" (SAGRA), a collection of surveys from different areas of the island and various years, accurately georeferenced. Information about plots are reported in Table 1. SAGRA also addresses a geographic gap, as plots from Sardinian grasslands are underrepresented in existing databases.

Table 1. Information relative to each survey contained in SAGRA dataset.

General information	Vegetation and management	Environmental information
Unique Identification Code (ID)	Total vegetation cover (%)	Elevation
Survey year	Vegetation structure	Slope
Survey date	Management type	Aspect
Surveyors' names	Duration	Vegetation series
Custodian	Grazing animals	Bioclimate
Country		Geology
Municipality		Land use
Site name		
Original project name		
Original project Identification code		
Farm name		
Field identification code		
Replicate number		
Longitude		
Latitude		
Location uncertainty (m)		
Number of resurveys		
Plot size		

Study area

Sardinia is located in the Mediterranean basin, encompassing an area of approximately 24,000 km^2. It boasts a coastline extending about 1900 km (Mori 1966) (Fig. 1).

The morphology of the island's terrain is predominantly mountainous, featuring a maximum elevation of 1834 m a.s.l. and an average elevation of 334 m a.s.l. (Mori 1966). Geologically, Sardinia comprises four main units: a Variscan crystalline basement characterized by Paleozoic magmatic intrusive and metamorphic complexes (in the east side); a Permian to Oligocene sedimentary marine succession (in the west side); an Upper Oligocene to Upper Miocene volcano-sedimentary succession, and Plio-Pleistocene basaltic lava flows (on the central part of the island). Additionally, volcanic and terrigenous Quaternary deposits occur in the main plains and along the coasts (Carmignani et al. 2016).

Approximately 28% of the island's total surface area is marked by outcropping rock and poorly developed soils, with depths not exceeding 10–15 cm. Only 18% of Sardinia's land area consists of irrigable soil (Vacca 2016). The climate is typically Mediterranean, characterized by dry and hot summers, and relatively rainy and mild winters. In Sardinia, annual precipitation ranges from 411 to over 1215 mm in the inner mountainous regions. The mean annual temperature ranges from 11.7 °C to 18.1 °C. Two macroclimate types have been identified: Mediterranean pluviseasonal oceanic, covering 99.1% of the total area, and Temperate oceanic (Canu et al. 2015).

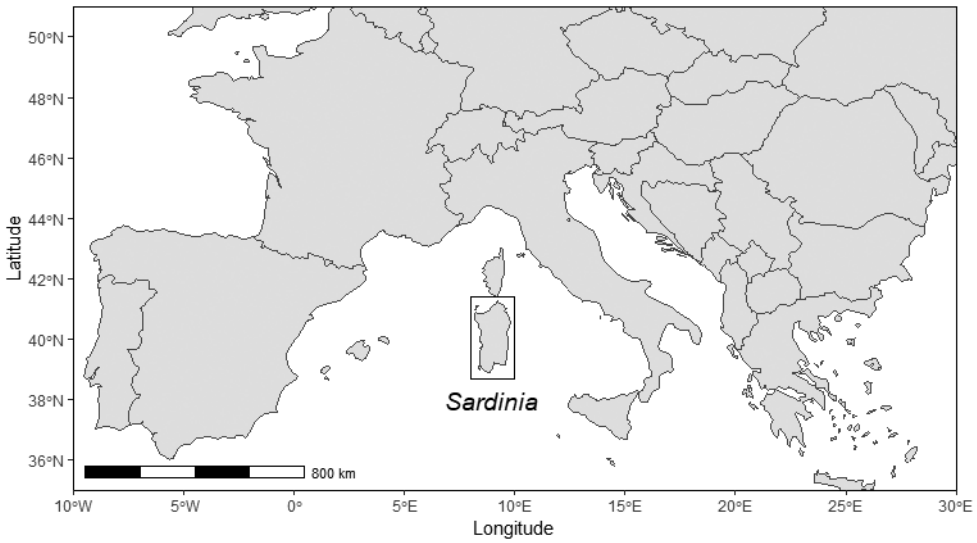

Figure 1. Location of Sardinia in the Mediterranean basin.

Data collection

Data on grasslands were gathered from ten projects spanning the years 2011 to 2021 (Bagella et al. 2013, 2014, 2020a, b; Rossetti et al. 2015; Seddaiu et al. 2018), employing a consistent sampling method. We used 2 m × 2 m plots (Angelini et al. 2016). Within homogeneous areas from an environmental and management perspective, referred to as "fields", we conducted three to five random replications. Within each plot, the abundance-dominance of all present plant species was quantified using the scale proposed by Braun-Blanquet (1932). The scale includes several categories allowing researchers to quantify the presence and relative importance. Surveys were carried out during spring and sometimes occasionally repeated in different years.

The surveyed vegetation can be mainly referred to the classses *Papaveretea rhoeadis* S. Brullo et al. 2001, *Polygono-Poetea annuae* Rivas-Mart. 1975, *Poetea bulbosae* Rivas Goday et Rivas-Martínez ex Navarro Andrés et Valle Gutiérrez 1984, and *Tuberarietea guttatae* Braun-Blanquet 1973 (Terzi et al. 2024).

Structure and content of the dataset

The data obtained from the ten projects were consolidated into a single file using Turboveg v. 2.135b (Hennekens and Schaminée 2001). To ensure consistency, plant names were standardized following Euro+Med (2006–2024). Additionally, the biological form of each species, as outlined by Pignatti (1982), was included in the dataset. Family classifications adhere to the APG IV (2016).

The vegetation surveys are associated with three categories of information: general, vegetation and management, and environmental (Table 1). The categories of vegetation structure and management. are detailed in Table 2. Environmental information was derived from open-source facilities (Table 3).

The geographic locations of the plots, either initially recorded in the field or later derived remotely, were then standardized to the same coordinate system, World Geodetic System 1984 (WGS84 - EPSG:4326).

SAGRA comprises 1277 surveys performed in 685 vegetation plots primarily located in the central-western and northeastern regions of the island of Sardinia. The plots were permanent and several surveys were repeated in different years. A total of 434 species were found, with the most represented families being Fabaceae, Poaceae and Asteraceae (Fig. 2A). Annual species (therophytes; T) outnumbered perennial species (Fig. 2B).

Most species were rarely recorded (Fig. 3). By contrast, seven species were recorded in more than 500 surveys (Fig. 4).

Open grasslands are the most represented vegetation type, followed by wooded grasslands, while the other types are sparsely represented across a few plots (Fig. 5A).

Table 2. Categories of vegetation structure, management, duration and grazing animals considered in SAGRA dataset.

Vegetation structure	Open grasslands *Herbaceous grasslands*	Bushed grasslands *Herbaceous grasslands with scattered bushes*	Wooded grasslands *Herbaceous grasslands with scattered trees* Two subunits: underneath the tree canopy and beyond the tree canopy	Clearings *Clearings in the woodlands 500–1000 m²*
Management	Grazed	Mown	Mown-grazed	
Duration	Temporary *Less than 5 years of age, included in a crop rotation*	Permanent *Naturally (self-seeded) or through cultivation (sown) and not included in the crop rotation of the holding for five years or longer (Commission Regulation EU No 796/2004).*	Mixed *Combination of the previous two categories*	
Grazing animals	Dairy sheep	Dairy cattle	Beef cattle	Mixed

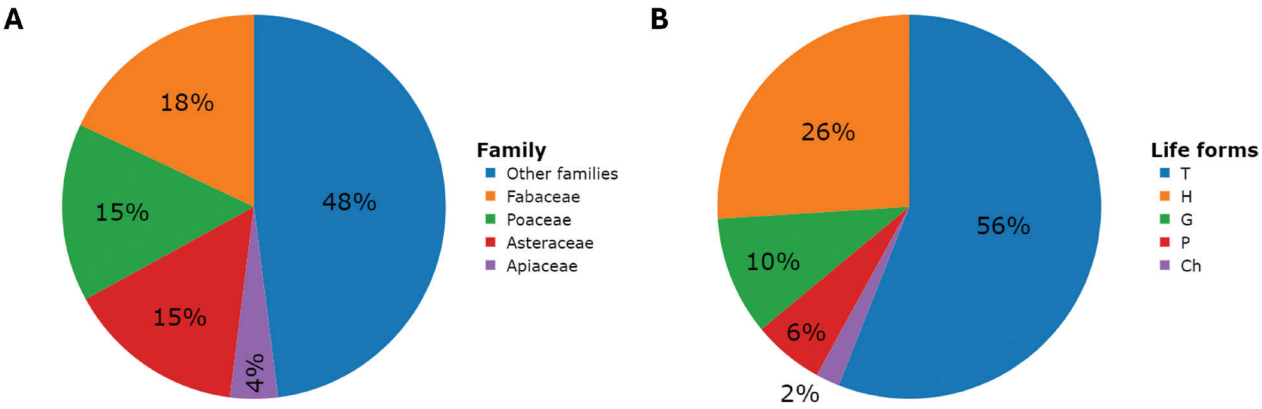

Figure 2. Percentage of plant families (**A**) and life forms (**B**) of the species listed in SAGRA dataset (Ch = Chamaephytes; G = Geophytes; H = Hemicryptophytes; P = Phanerophytes; T = Therophytes).

Table 3. Sources of the environmental information.

Information	Source
Elevation	Digital Elevation Model with a resolution of 25 m and vertical accuracy of +/- 7 m RMSE (Copernicus Land Monitoring Service – EU-DEM graziv1.1)
Slope	
Aspect	
Vegetation series	Bacchetta et al. (2009)
Bioclimate	Canu et al. (2015)
Geology	Sardegna Geoportale (2024)
Land use	Corine land use classification up to five levels

The majority of plots are subjected to grazing activities (Fig. 5B). In terms of duration, the temporary type prevails (Fig. 5C). Lastly, there is a nearly equal representation of beef cattle and dairy sheep among grazing animals (Fig. 5D), with mixed categories primarily consisting of dairy sheep/beef cattle and dairy sheep/goats.

The plots span a broad elevation range, from 3 to 995 m a.s.l. They are predominantly located on granitic and effusive substrates, with a prevailing northwest-oriented aspect.

Twelve distinct isobioclimates are represented, with a prevalence of the Lower Mesomediterranean, mainly Lower Mesomediterranean, lower subhumid, weak euoceanic.

Concerning the plant landscape, the vegetation series more present correspond to those of the Sardinian, calcifuge cork oak forests of the associations *Galio scabri-Quercetum suberis* (thermo-mesomediterranean) and *Violo dehnhardtii-Quercetum suberis* (meso-mediterranean).

Based on the Corine land use classification, the plots are predominantly categorized as Non-irrigated arable land, followed by Artificial meadows.

Conclusions and future perspectives

The compilation of the SAGRA dataset resulted from rigorous data collection efforts and a meticulous process of data organization, digitalization, and structuring. Initially emerging as a collection of local projects, its organizational framework enables scalability or integration into existing vegetation databases. The species predominantly represented in the surveys are Mediterranean therophytes, adapted to seasonal precipitation patterns and exhibiting tolerance to disturbances (Tárrega et al. 2009; Fernández-Moya et al. 2011). The distribution of species within the three most abundant families mirrors the characteristics of these grasslands. Poaceae and Fabaceae encompass

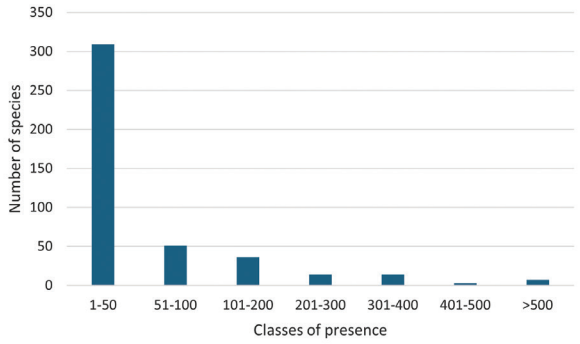

Figure 3. Frequency distribution of the species presence in the surveys.

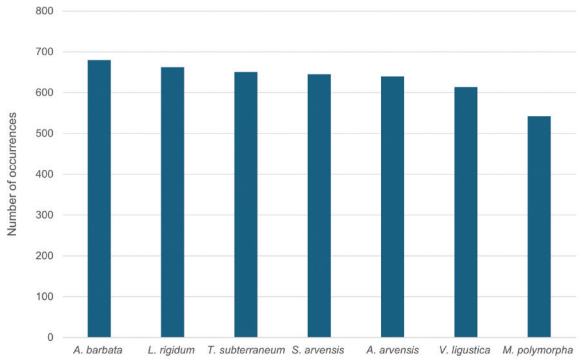

Figure 4. Number of occurrences of the seven Mediterranean therophytes recorded in more than 500 surveys (*A. barbata* = *Avena barbata* Link; *L. rigidum* = *Lolium rigidum* Gaudin; *T. subterraneum* = *Trifolium subterraneum* L.; *S. arvensis* = *Sherardia arvensis* L.; *A. arvensis* = *Anthemis arvensis* L.; *V. ligustica* = *Vulpia ligustica* (All.) Link; *M. polymorpha* = *Medicago polymorpha* L.).

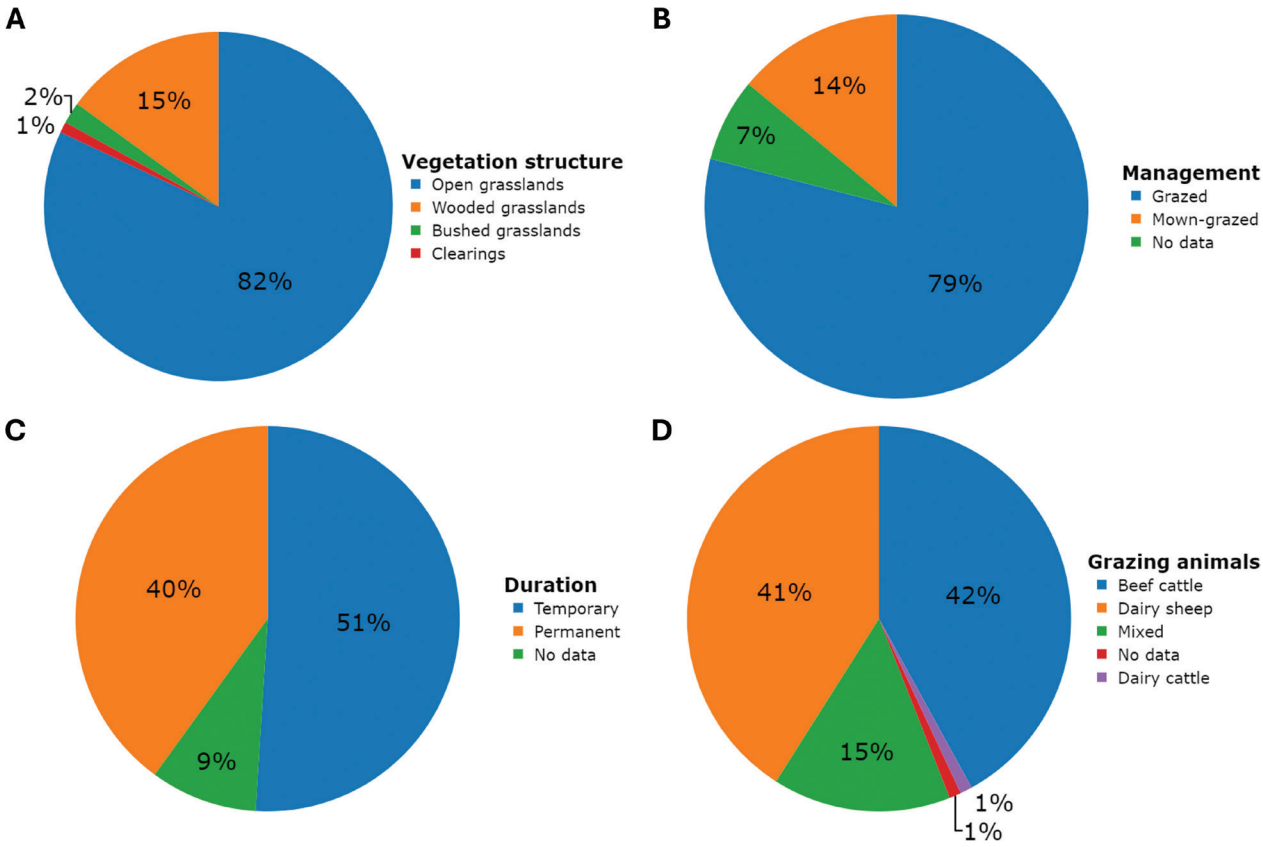

Figure 5. Plot characteristics: vegetation structure (**A**), management (**B**), duration (**C**), grazing animals (**D**).

numerous good and excellent forage species (Verdinelli et al. 2022), whereas Asteraceae comprise thorny and prickly species highlighting the encroachment of grasslands and thereby reducing vegetation cover of palatable species for livestock (Bagella et al. 2019). The vegetation plots are located in sectors representative of various common environmental conditions on the island and different parts of the Mediterranean basin (Caballero et al. 2009; Rossetti et al. 2015; Seddaiu et al. 2018). SAGRA represents a dataset with numerous perspectives of application. The use of species-specific information can address questions related to responses to diverse environmental gradients, and exploring species and community responses, as well as their relationships with ecosystem services linked to specific management types (Garnier et al. 2016; Chelli et al. 2019). The availability of this georeferenced dataset will be useful to define spatial models of grassland diversity in Sardinia. A forthcoming step for SAGRA involves establishing an accessible structure to enhance data management. It will be made accessible through vegetation databases for broader-scale analyses. The dataset will support future studies on Mediterranean grasslands.

Data request

Data can be obtained through the official vegetation database of the Italian Association for Vegetation Science VegItaly by contacting the VegItaly Steering Committee (https://www.scienzadellavegetazione.it/en/vegitaly-3/) or by contacting the dataset custodian directly (Simonetta Bagella: sbagella@uniss.it).

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