

Supplementary material

Study site description

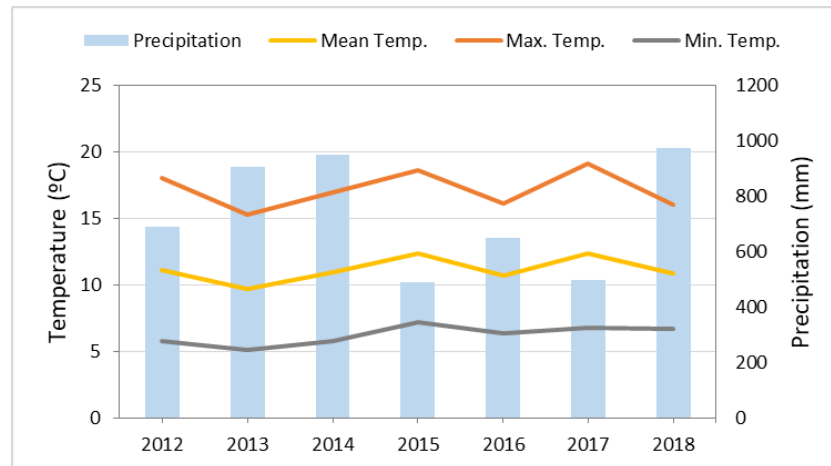


Figure S1. Average temperatures (°C) and accumulated precipitation (mm) from the beginning of the growing season (early March) to the date of the vegetation surveys (end of July) for each year during the study. Data from *Irabia* climatic station (42°59'N 1°9'W, 822 m a.s.l., 3 km from the study area; <http://meteo.navarra.es/>). The mean annual precipitation is 1990.9 mm and the mean annual temperature is 9.3 °C (March: 5.7 °C, July: 16.8 °C).

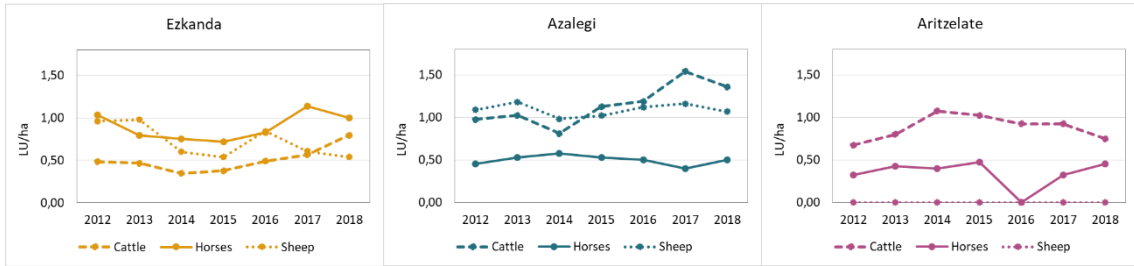
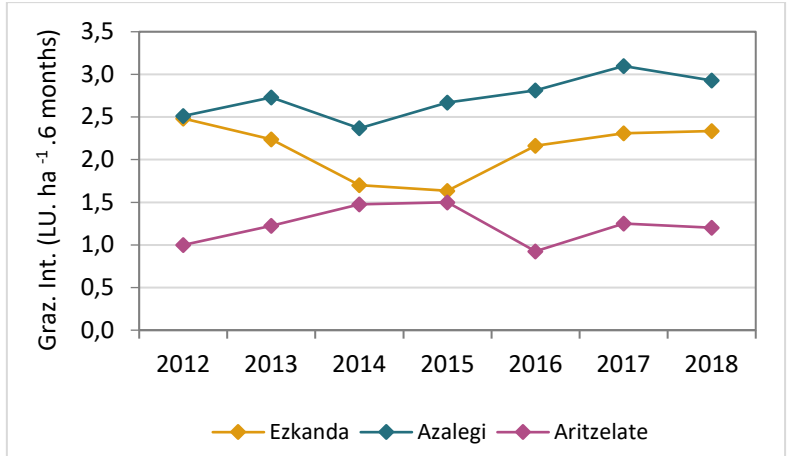


Figure S2. Maximum estimated livestock stocking rate at the three experimental sites during the study period and the grazing intensity of the three livestock species at each site (cattle, horses and sheep). Information provided by Aezkoa Valley's stakeholders and administrative officers.

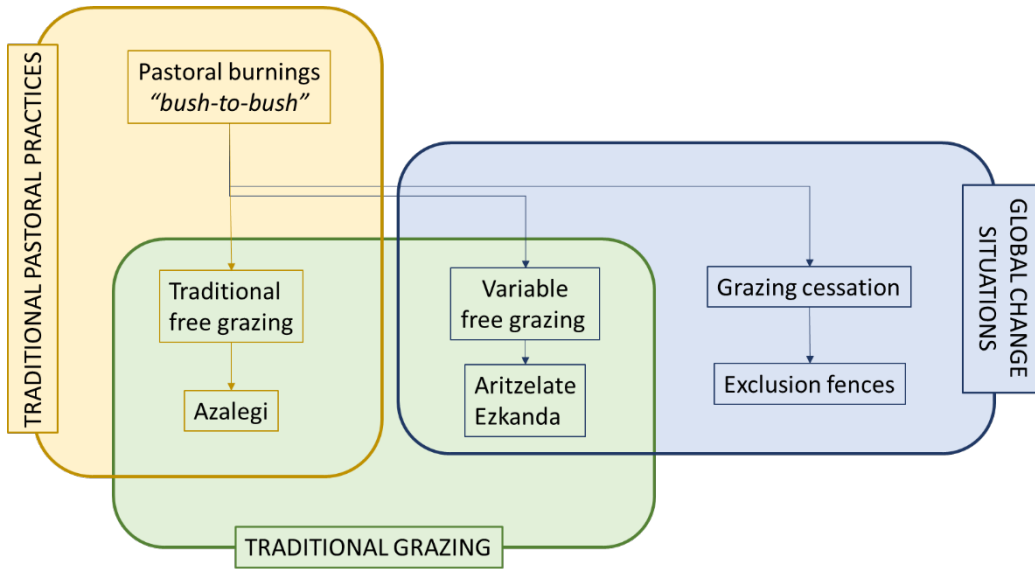


Figure S3. Scheme of the burning and grazing practices performed during the study.

Survey methods

Table S1. Size of permanent quadrats

Site	Treatment	Area of permanent quadrats (m ²)		
		1	2	3
Ezkanda	B ⁺ G ⁺	0.81	1.37	1.21
Ezkanda	B ⁺ G ⁻	0.81	0.80	1.10
Azalegi	B ⁺ G ⁺	1.16	0.77	1.00
Azalegi	B ⁺ G ⁻	0.80	0.80	1.30
Aritzelate	B ⁺ G ⁺	0.80	0.48	0.48
Aritzelate	B ⁺ G ⁻	0.99	0.80	0.70

Statistical analysis

Table S2. Generalized additive mixed models (GAMMs) for growth forms groups, subgroups, and plant species, diversity indices and leaf length and maximum height. The table shows the best model for each variable. Fixed effects: S, site; G, grazing; D, date; F, fire.

Variable	Model
Plant covers	
<i>U. gallii</i>	S + G + s(D by S) + s(D by G)
Graminoids	S + G + s(D by S) + s(D by G)
<i>B. rupestre</i>	S + s(D by S)
<i>F. rubra</i>	S + G + s(D by G)
<i>A. capillaris</i>	S x G + s(D by G)
Forbs	S x G + s(D by G)
Rosette	S + G + s(D by G)
Bare soil	S x G + s(D by G)
Diversity indices	
Species richness	S + G + s(D by G)
Shannon index	S + G + s(D by S) + s(D by G)
Pielou's index	S*G + s(D by S)
<i>B. rupestre</i>	
Leaf length	S + G + F + S x G + S x F + s(D by S) + s(D by G)
Max. height	S x G x F + s(D by G)

Recorded plant species in the study

We recorded 67 species of vascular plants in the floristic surveys during the study (Table S2), of which 46 (69%) were shared by at least two sites. There were two trees (seedlings), six shrubs (3 legumes –*Fabaceae*, 3 heaths –*Ericaceae*), 1 fern (*Polypodiaceae*), 14 graminoids (11 grasses –*Gramineae*, 2 sedges – *Cyperaceae* and 1 rush –*Juncaceae*), and 44 forbs species (of which six were legumes –*Fabaceae*).

Table S3. Plant species recorded during the study. Abbreviation, species name and family. Plant nomenclature according with Flora Iberica (Castroviejo 1986-2019), Flora Europaea (Tutin et al. (1964-1980), only for Poaceae) and Euro+Med PlantBase for *Brachypodium*

Abr.	Species name	Family
acecam	<i>Acer campestre</i> L.	Aceraceae
achmil	<i>Achillea millefolium</i> L.	Asteraceae
agrcap	<i>Agrostis capillaris</i> L.	Poaceae
apharv	<i>Aphanes arvensis</i> L.	Rosaceae
avesul	<i>Avenula marginata</i> (Lowe) J. Holub subsp. <i>sulcata</i> (Gay ex Delastre) Franco	Poaceae
belper	<i>Bellis perennis</i> L.	Asteraceae
brarup	<i>Brachypodium rupestre</i> (Host) Schübler. & Martens.	Poaceae
brimed	<i>Briza media</i> L.	Poaceae
Briofi*	Bryophyta	--
broere	<i>Bromus erectus</i> Hudson	Poaceae
calvul	<i>Calluna vulgaris</i> (L.) Hull	Ericaceae
camsch	<i>Campanula scheuchzeri</i> Vill.	Campanulaceae
carcar	<i>Carex caryophyllea</i> Latourr.	Cyperaceae
carfla	<i>Carex flacca</i> Schreber	Cyperaceae

cerfon	<i>Cerastium fontanum</i> Baumg.	Caryophyllaceae
ciraca	<i>Cirsium acaule</i> Scop.	Asteraceae
cireri	<i>Cirsium eriophorum</i> (L.) Scop.	Asteraceae
cirpal	<i>Cirsium palustre</i> (L.) Scop.	Asteraceae
cramon	<i>Crataegus monogyna</i> Jacq.	Rosaceae
crugla	<i>Cruciata glabra</i> (L.) Ehrend.	Rubiaceae
cyncri	<i>Cynosurus cristatus</i> L.	Poaceae
cytsco	<i>Cytisus scoparius</i> (L.) Link	Fabaceae
dabcan	<i>Daboecia cantabrica</i> (Hudson) C. Koch	Ericaceae
dandec	<i>Danthonia decumbens</i> (L.) DC.	Poaceae
desfle	<i>Deschampsia flexuosa</i> (L.) Trin.	Poaceae
dicot	Dicot seedling	
erivag	<i>Erica vagans</i> L.	Ericaceae
erybou	<i>Eryngium bourgatii</i> Gouan	Apiaceae
eupang	<i>Euphorbia angulata</i> Jacq.	Euphorbiaceae
fesrub	<i>Festuca rubra</i> L.	Poaceae
galest	<i>Galium estebanii</i> Sennen	Rubiaceae
galsax	<i>Galium saxatile</i> L.	Rubiaceae
galver	<i>Galium verum</i> L.	Rubiaceae
genpil	<i>Genista pilosa</i> L.	Fabaceae
hipcom	<i>Hippocrepis comosa</i> L. subsp. <i>comosa</i>	Fabaceae
hyprad	<i>Hypochaeris radicata</i> L.	Asteraceae
hypric	<i>Hypericum richeri</i> Vill. subsp. <i>burseri</i> (DC.) Nyman	Guttiferae
latlin	<i>Lathyrus linifolius</i> (Reichard) Bässler	Fabaceae
leohis	<i>Leontodon hispidus</i> L. subsp. <i>hispidus</i>	Asteraceae

lotcor	<i>Lotus corniculatus</i> L.	Fabaceae
luzcam	<i>Luzula campestris</i> (L.) DC.	Juncaceae
medlup	<i>Medicago lupulina</i> L.	Fabaceae
piloff	<i>Pilosella officinarum</i> F.W. Schultz & Schultz Bip.	Asteraceae
pimsax	<i>Pimpinella saxifraga</i> L.	Apiaceae
plalan	<i>Plantago lanceolata</i> L.	Plantaginaceae
plamed	<i>Plantago media</i> L.	Plantaginaceae
poaann	<i>Poa annua</i> L.	Poaceae
poapra	<i>Poa pratensis</i> L.	Poaceae
polser	<i>Polygala serpyllifolia</i> J. A. C. Hose	Polygalaceae
potere	<i>Potentilla erecta</i> (L.) Rauschel	Rosaceae
potmon	<i>Potentilla montana</i> Brot.	Rosaceae
pruvul	<i>Prunella vulgaris</i> L.	Lamiaceae
pteaqu	<i>Pteridium aquilinum</i> (L.) Kuhn	Polypodiaceae
ranacr	<i>Ranunculus acris</i> L.	Ranunculaceae
ranbul	<i>Ranunculus bulbosus</i> L.	Ranunculaceae
sciver	<i>Scilla verna</i> Hudson	Liliaceae
sertin	<i>Serratula tinctoria</i> L.	Asteraceae
stegra	<i>Stellaria graminea</i> L.	Caryophyllaceae
stehol	<i>Stellaria holostea</i> L.	Caryophyllaceae
taroff	<i>Taraxacum</i> gr. <i>officinale</i>	Asteraceae
thypra	<i>Thymus praecox</i> Opiz	Lamiaceae
tripra	<i>Trifolium pratense</i> L.	Fabaceae
trirep	<i>Trifolium repens</i> L.	Fabaceae
ulegal	<i>Ulex gallii</i> Planch. subsp. <i>gallii</i>	Fabaceae

veragr	<i>Veronica agrestis</i> L.	Scrophulariaceae
vercha	<i>Veronica chamaedrys</i> L.	Scrophulariaceae
veroff	<i>Veronica officinalis</i> L.	Scrophulariaceae
violiv	<i>Viola riviniana</i> Reichenb.	Violaceae

* *We recorded mosses in general, but not at the species level.*

Castroviejo, S. (Ed.). 1986-2019. Flora Iberica. Real Jardín Botánico, CSIC. Madrid.

Euro+Med. 2006-2020. Euro+Med PlantBase - the information resource for Euro-Mediterranean plant diversity. <http://ww2.bgbm.org/EuroPlusMed>

Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters & D.A. Webb (Eds.) 1964–1980. Flora Europaea. Cambridge University Press, Cambridge.

Results: supplementary graphs

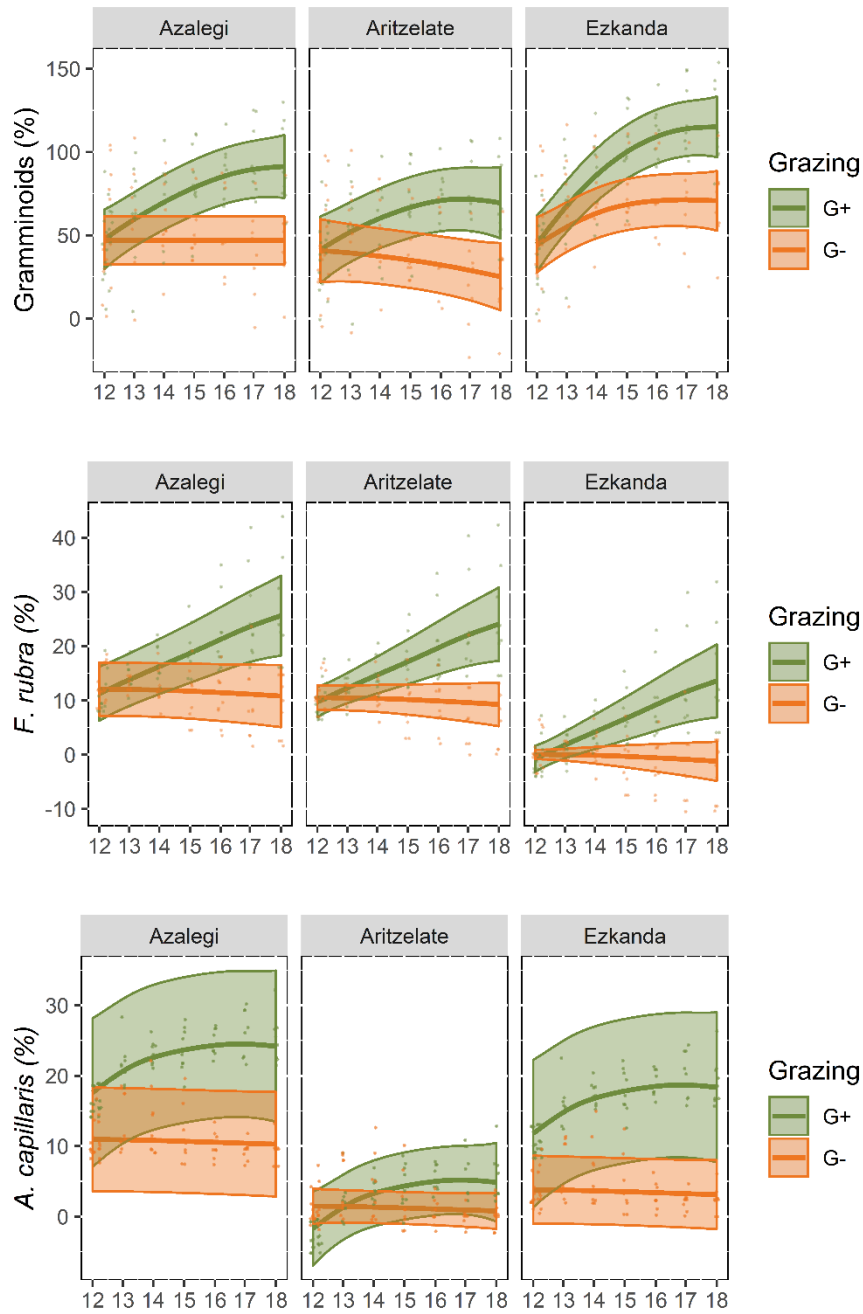


Figure S4. Total graminoids, *F. rubra* and *A. capillaris* cover in burned plots from 2012 to 2018 at the three study sites. Expected values (line), partial residuals (dots) and the 95% confidence interval (shaded area). Grazed plots (G⁺); ungrazed plots (G⁻).

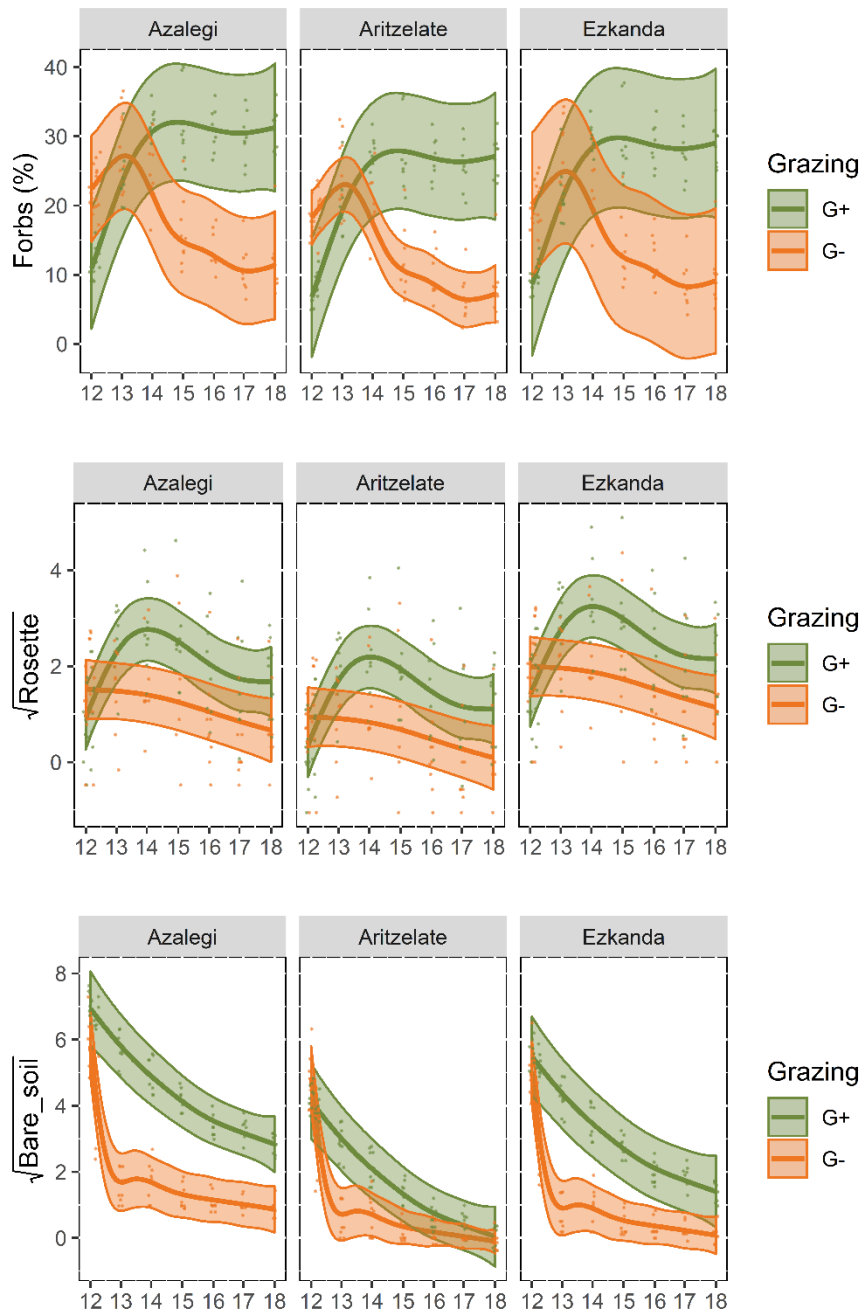


Figure S5. Total forb and rosette-forming species cover and bare soil in burned plots from 2012 to 2018 at the three study sites. Expected values (line), partial residuals (dots) and the 95% confidence interval (shaded area). Grazed plots (G⁺); ungrazed plots (G⁻).

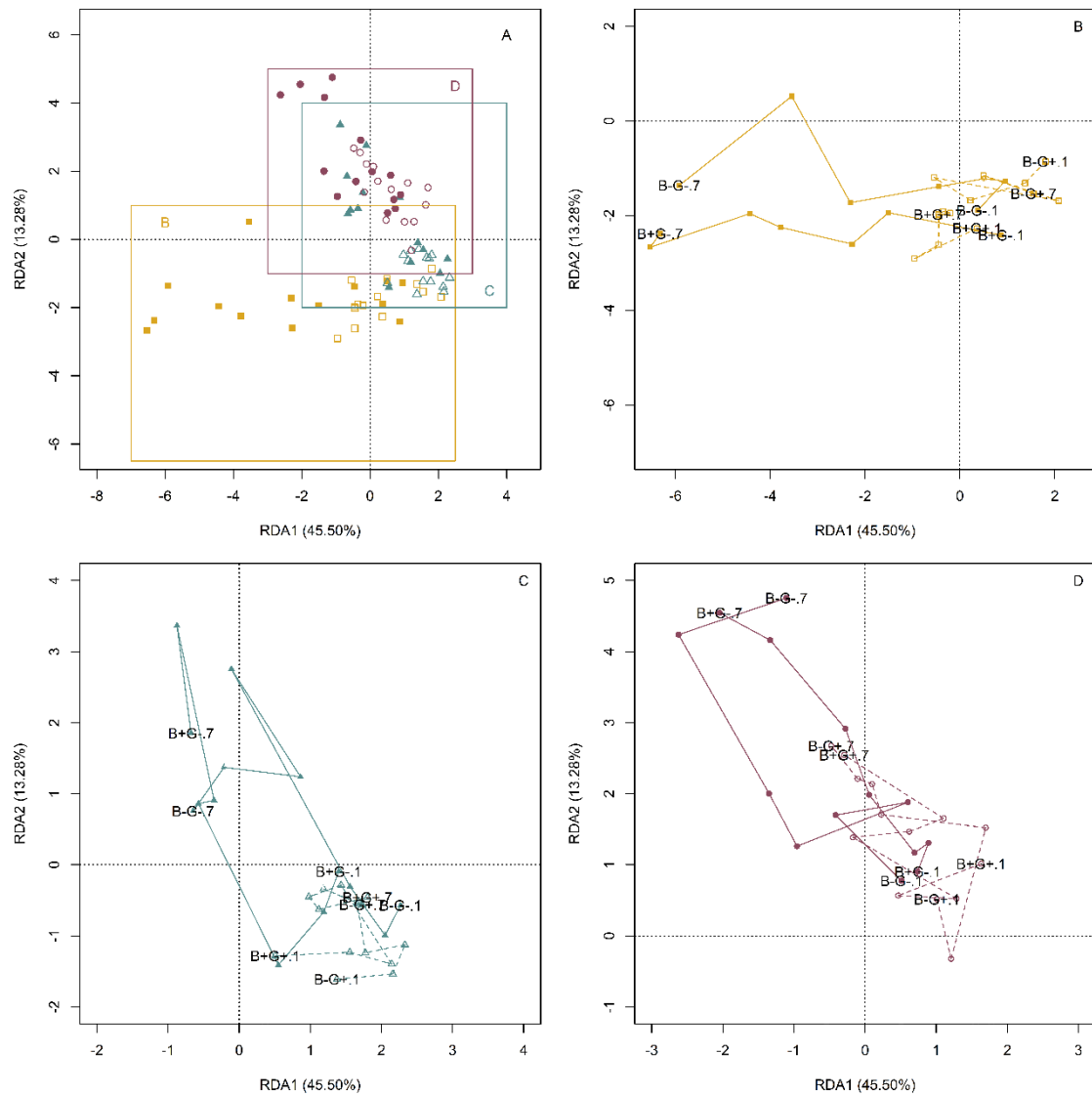


Figure S6. RDA ordination diagrams of floristic composition measured by the Point Quadrat Method, plant community evolution for each site over time. (A) Ordination diagram showing inventories at the three sites. Sites indicated by colours: yellow, Ezkanda; blue, Azalegi; pink, Aritzelate. (B - D) temporal trajectory vectors for the inventories (dotted lines, grazed plots; solid lines, ungrazed plots) of the three study sites (B, Ezkanda; C, Azalegi; D, Aritzelate). B⁺G⁺, burned and grazed; B⁺G⁻, burned and ungrazed; B⁻G⁺, unburned and grazed; B⁻G⁻ unburned and ungrazed; 1, July 2012; 7, July 2018.



Figure. S7. Photographs of the grazing excluded areas at the three study sites: Aritzelate, Azalegi and Ezkanda.