

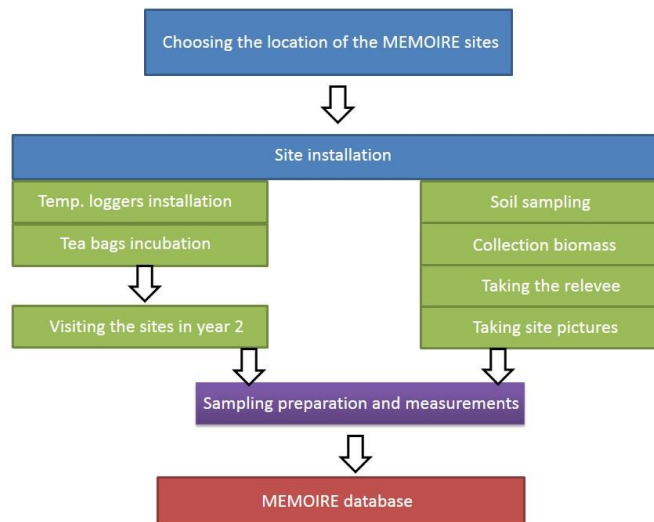
Fine-scale Monitoring of climate change Effects on the high-Mountain gRassland Ecosystem in the Romanian Carpathians (MEMOIRE)

Report on TASK 1 (2018)

This task had to accomplish two main activities, according to the work programme: (i) defining the field surveying protocol; (ii) planning, coordinating and implementing the field campaigns in the Romanian Carpathians. **Both activities had been achieved.** Starting with the protocol, we implemented research activities in the field in order to install new long-term monitoring sites in the Romanian Carpathians.

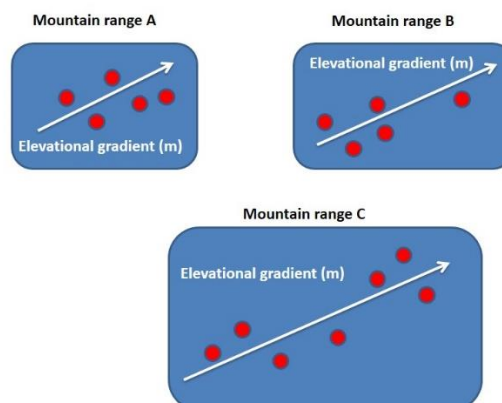
Brief description of the field protocol

The sampling methods include tasks that will be achieved in a specific order. Sampling actions are grouped in: (i) general sampling scheme, (ii) access and choosing the sampling sites, (iii) site installation and (iv) measurements on the collected samples.



General sampling scheme

Monitoring sites will be located across the Romanian Carpathians, in representative grasslands. Basically, we will follow an elevational gradient. The general scheme comprises three main mountain ranges: Parang, Rodna and Apuseni.



Access and choosing the site location

We recommend that the location of the sites to be safe. Moreover, site location should allow an optimal working conditions and transportation of the sampled material (e.g. soil, biomass). Working time is an important issue to be considered.

Importantly, the location of the MEMOIRE sites should be chosen to be suitable for remote sensing analyses. Disturbed sites will be avoided.

Materials

The equipment that is necessary for the field sampling includes: proper clothes, transportation equipment (e.g. boxes, plastic bags etc.), equipment for recording ground ecological data (e.g. data loggers, Rooibos tea bags, scale, metal detector, logger batteries, soil sieves etc.)



Organizing equipment into plastic boxes, in categories

Long-term monitoring site installation

Preparation and field work consists of the following parts:

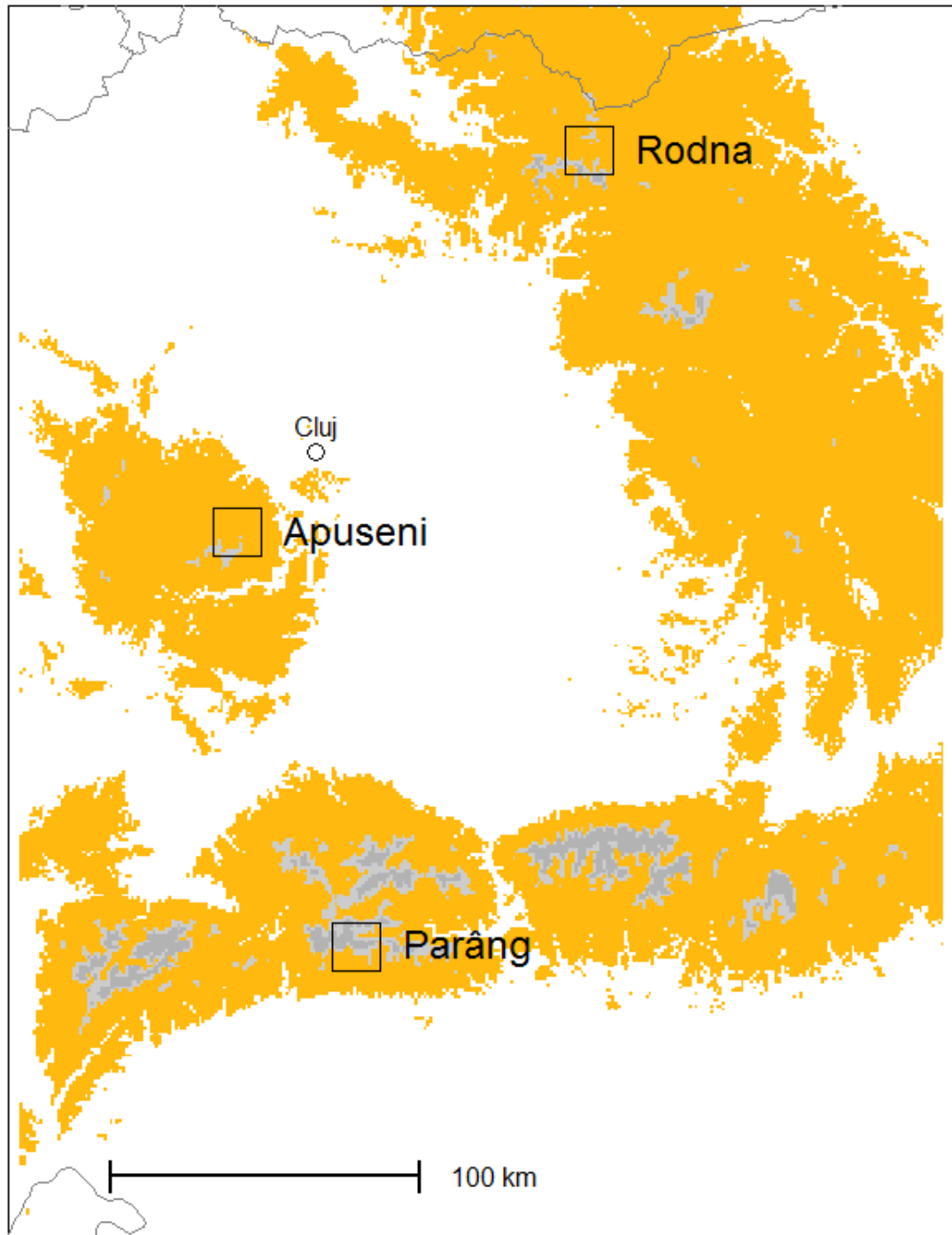
1. Preparing and printing the field sheets
2. Marking the site limits in the field
3. Making the relevee
4. Aboveground clipping from 0.25 m² plots and weighing
5. Soil sampling (extraction) and preparation
6. Data loggers installing (2 pieces / sites)
7. Tea bags burring (5 pieces / sites)
8. Taking photographs of the site

Scientific results of the TASK 1 (2018): (ii) planning, coordinating and implementing the field campaigns in the Romanian Carpathians.

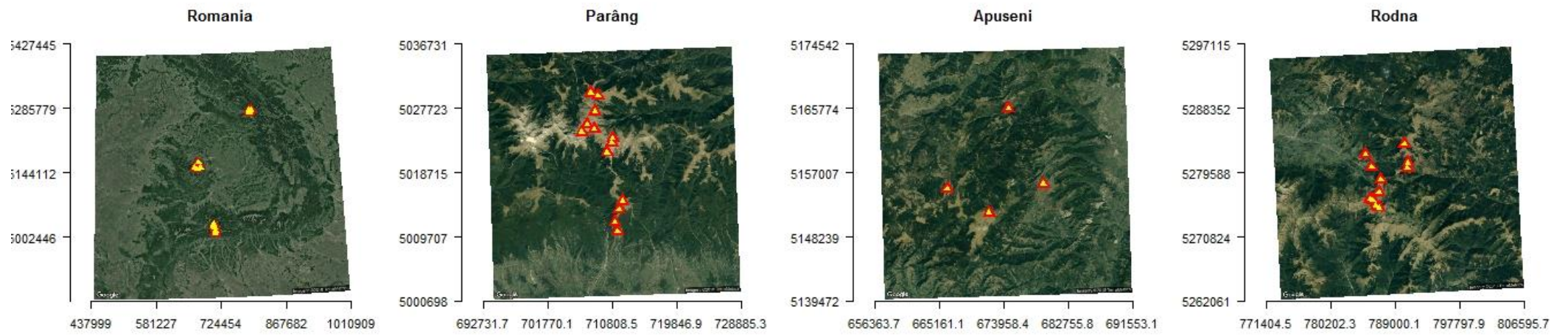
Overview of the sampling done in 2018

According to our goal, we sampled three main mountain ranges in the Romanian Carpathians, as presented in the following table. In each mountain, we installed sites along an elevation gradient. We installed 14 sites in Parang, 11 sites in Rodna and 4 in Apuseni (29 sites in total).

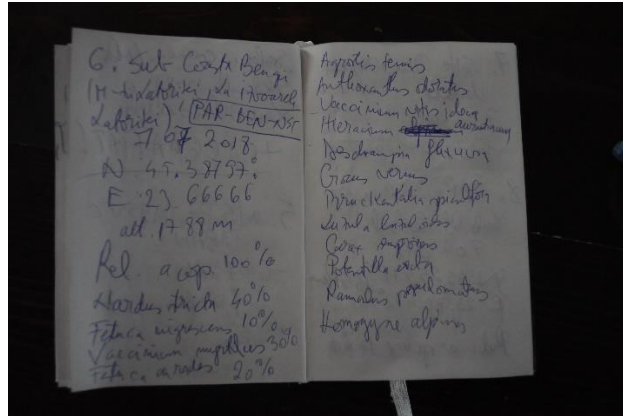
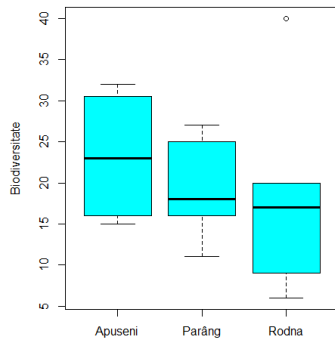
Site code	Range	Community type	Latitude	Longitude	Elevation (m)
PARGALJUN	Parâng	Juncus trifidus	45.328	23.689	2111
PARSCAAGR	Parâng	Festuca rupicola	45.215	23.693	975
PARMAGAGR	Parâng	Agrostis tenuis	45.228	23.689	1152
PARBENNST	Parâng	Nardus stricta	45.388	23.667	1788
PARSTECSE	Parâng	Carex sempervirens	45.391	23.654	1961
PARLATDES	Parâng	Deschampsia caespitosa	45.368	23.661	1915
PARIEZFAI	Parâng	Festuca airoides	45.352	23.645	2144
PARSTEAIR	Parâng	Festuca airoides	45.393	23.654	2030
PARGALVAC	Parâng	Vaccinium myrtillus	45.333	23.690	2023
PARCERNST	Parâng	Nardus stricta	45.254	23.705	1546
PARCERFNI	Parâng	Festuca nigrescens	45.243	23.697	1385
PARMOHCCU	Parâng	Carex curvula	45.342	23.636	2319
PARODYCCU	Parâng	Carex curvula	45.346	23.658	2157
PARODYNST	Parâng	Nardus stricta	45.316	23.680	1740
RODPLANST	Rodna	Nardus stricta	47.582	24.813	1595
RODCEADES	Rodna	Deschampsia flexuosa	47.616	24.869	1476
RODPRIFNI	Rodna	Festuca nigrescens	47.609	24.867	1432
RODBORCEN	Rodna	Nardus stricta	47.613	24.802	1024
RODBORBME	Rodna	Briza media	47.629	24.792	1116
RODODDNST	Rodna	Nardus stricta	47.597	24.818	1565
RODGARDES	Rodna	Deschampsia caespitosa	47.572	24.802	1827
RODGARCCU	Rodna	Carex curvula	47.566	24.807	2091
RODSAUNST	Rodna	Nardus stricta	47.574	24.796	1912
RODGARJUN	Rodna	Juncus trifidus	47.563	24.812	2138
RODCEANST	Rodna	Nardus stricta	47.640	24.863	1648
APUMUNNST	Apuseni	Nardus stricta	46.495	23.240	1803
APUTINNST	Apuseni	Nardus stricta	46.526	23.167	1568
APUCERFRU	Apuseni	Festuca rubra	46.623	23.280	1051
APUSOVAGT	Apuseni	Agrostis tenuis	46.529	23.338	1229



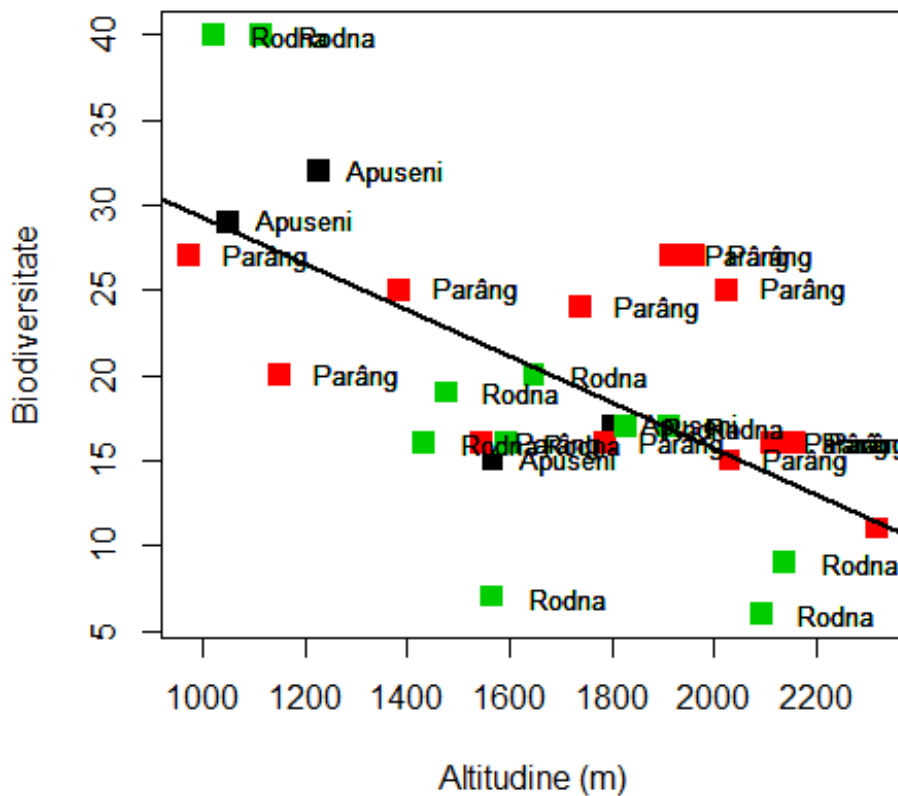
Distribution of the three mountain ranges sampled in 2018.
Gray colors represent high mountain areas.



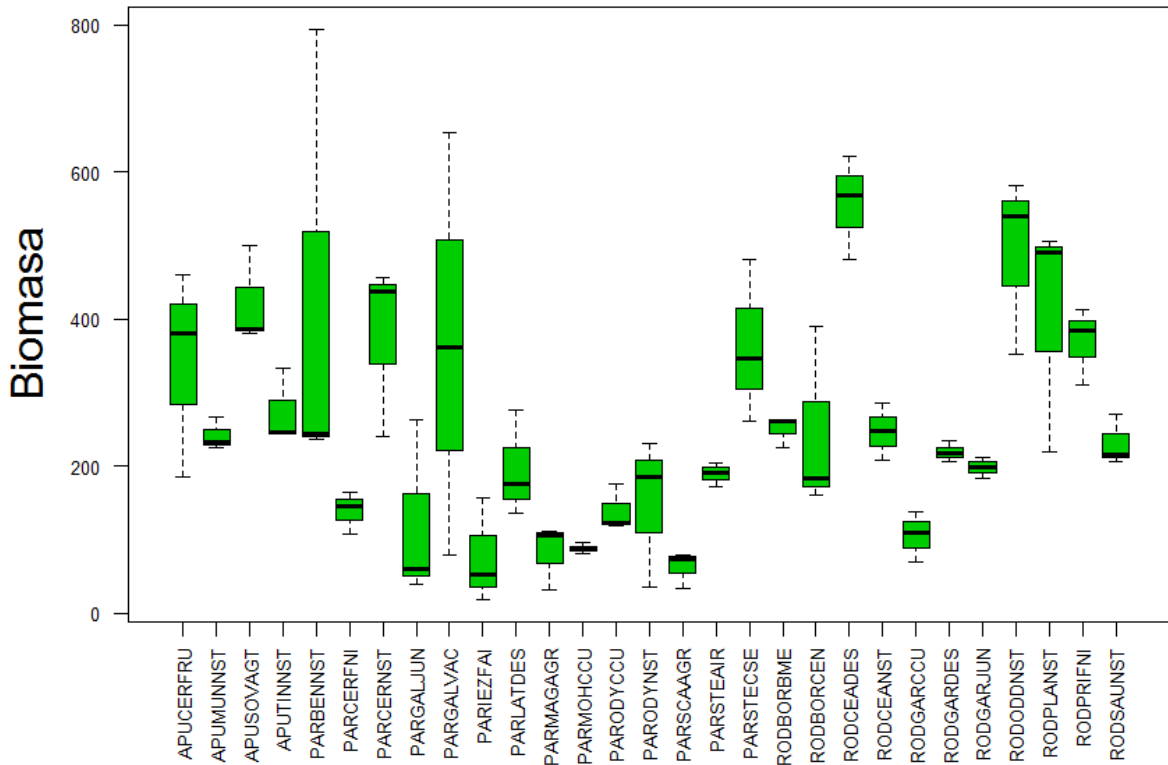
Google Earth images showing the distribution of the MEMOIRE sites installed in 2018: at the scale of the Romanian Carpathians (first panel) and within each range (the following three panels).



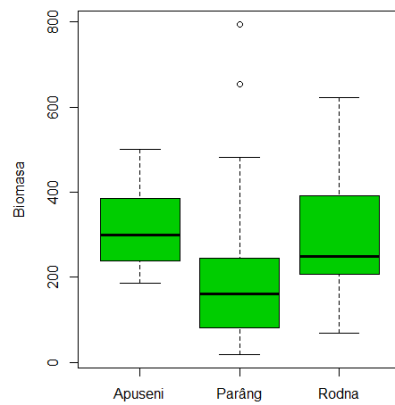
Biodiversity estimated as the number of vascular plants within the sites. Sites in Apuseni were the most species rich, while some sites in Rodna were species poor.



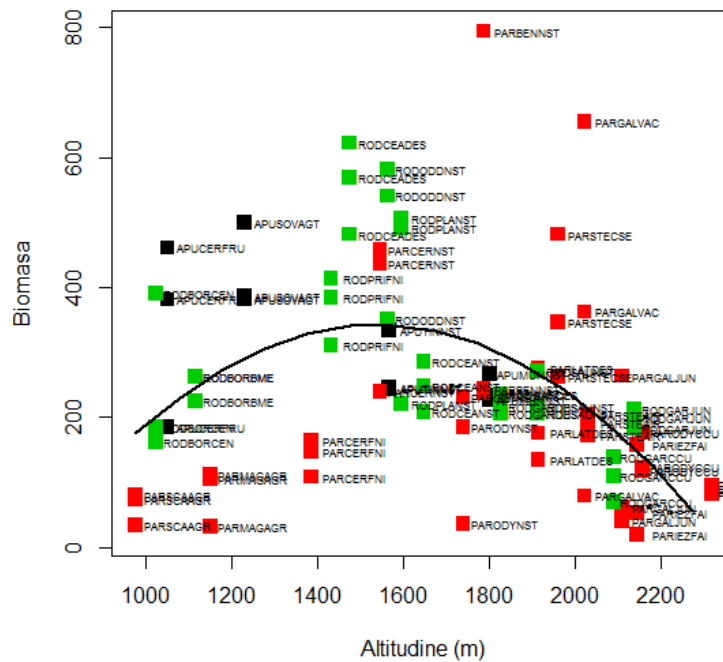
Along the elevational gradient, we had a highly significant relationships with the number of species. Point colors represent the mountain ranges.



Raw values of biomass measurements, which reflected a high variability both between and within sites.



We recorder a high aboveground biomass within sites, but not so well separated between ranges. However, Parand had the lowest values of aboveground biomass.



The relationship between biomass and elevation was polynomial, with the most productive habitats at intermediate elevations (around 1600-1800 m). Mountain ranges were not so well discriminated.

Ecosystem parameters recorded within the sites

Site code	Biomass	Biodiversity	Dominant species
APUCERFRU	381.3	29	Agrostis capillaris, Festuca rubra
APUCERFRU	185.9	29	Agrostis capillaris, Festuca rubra
APUCERFRU	461.0	29	Agrostis capillaris, Festuca rubra
APUMUNNST	226.2	17	Nardus stricta, Festuca nigrescens, Avenella flexuosa
APUMUNNST	266.8	17	Nardus stricta, Festuca nigrescens, Avenella flexuosa
APUMUNNST	233.3	17	Nardus stricta, Festuca nigrescens, Avenella flexuosa
APUSOVAGT	387.2	32	Agrostis capillaris, Arrhenatherum elatius
APUSOVAGT	500.2	32	Agrostis capillaris, Arrhenatherum elatius
APUSOVAGT	381.8	32	Agrostis capillaris, Arrhenatherum elatius
APUTINNST	243.8	15	Nardus stricta, Avenella flexuosa
APUTINNST	246.1	15	Nardus stricta, Avenella flexuosa
APUTINNST	333.5	15	Nardus stricta, Avenella flexuosa
PARBENNST	237.4	16	Nardus stricta, Vaccinium myrtillus, Festuca airoides, Festuca nigrescens
PARBENNST	244.2	16	Nardus stricta, Vaccinium myrtillus, Festuca airoides, Festuca nigrescens
PARBENNST	794.1	16	Nardus stricta, Vaccinium myrtillus, Festuca airoides, Festuca nigrescens
PARCERFNI	164.0	25	Festuca nigrescens, Nardus stricta, Agrostis capillaris, Pilosella aurantiaca
PARCERFNI	146.6	25	Festuca nigrescens, Nardus stricta, Agrostis capillaris, Pilosella aurantiaca

Site code	Biomass	Biodiversity	Dominant species
PARCERFNI	108.6	25	Festuca nigrescens, Nardus stricta, Agrostis capillaris, Pilosella aurantiaca
PARCERNST	240.4	16	Nardus stricta
PARCERNST	457.5	16	Nardus stricta
PARCERNST	437.5	16	Nardus stricta
PARGALJUN	263.8	16	Festuca airoides, Juncus trifidus, Agrostis rupestris
PARGALJUN	61.4	16	Festuca airoides, Juncus trifidus, Agrostis rupestris
PARGALJUN	40.4	16	Festuca airoides, Juncus trifidus, Agrostis rupestris
PARGALVAC	362.6	25	Vaccinium myrtillus, Festuca airoides, Nardus stricta
PARGALVAC	654.0	25	Vaccinium myrtillus, Festuca airoides, Nardus stricta
PARGALVAC	79.4	25	Vaccinium myrtillus, Festuca airoides, Nardus stricta
PARIEZFAI	157.9	16	Festuca airoides, Nardus stricta, Carex curvula, Poa media, Potentilla aurea subsp. chrysocraspeda, Agrostis rupestris, Phyteuma confusum
PARIEZFAI	53.2	16	Festuca airoides, Nardus stricta, Carex curvula, Poa media, Potentilla aurea subsp. chrysocraspeda, Agrostis rupestris, Phyteuma confusum
PARIEZFAI	19.0	16	Festuca airoides, Nardus stricta, Carex curvula, Poa media, Potentilla aurea subsp. chrysocraspeda, Agrostis rupestris, Phyteuma confusum
PARLATDES	276.1	27	Nardus stricta, Festuca airoides, Festuca nigrescens, Deschampsia cespitosa, Vaccinium myrtillus, Carex sempervirens
PARLATDES	135.8	27	Nardus stricta, Festuca airoides, Festuca nigrescens, Deschampsia cespitosa, Vaccinium myrtillus, Carex sempervirens
PARLATDES	176.0	27	Nardus stricta, Festuca airoides, Festuca nigrescens, Deschampsia cespitosa, Vaccinium myrtillus, Carex sempervirens
PARMAGAGR	31.8	20	Agrostis capillaris, Festuca rubra, Nardus stricta, Pilosella officinarum
PARMAGAGR	106.4	20	Agrostis capillaris, Festuca rubra, Nardus stricta, Pilosella officinarum
PARMAGAGR	112.0	20	Agrostis capillaris, Festuca rubra, Nardus stricta, Pilosella officinarum
PARMOHCCU	87.6	11	Carex curvula, Festuca airoides, Oreochloa disticha, Sesleria coerulans
PARMOHCCU	96.2	11	Carex curvula, Festuca airoides, Oreochloa disticha, Sesleria coerulans
PARMOHCCU	82.0	11	Carex curvula, Festuca airoides, Oreochloa disticha, Sesleria coerulans
PARODYCCU	176.4	16	Carex curvula, Festuca airoides
PARODYCCU	119.0	16	Carex curvula, Festuca airoides
PARODYCCU	123.5	16	Carex curvula, Festuca airoides
PARODYNST	185.0	24	Nardus stricta, Avenella flexuosa, Festuca airoides, Festuca nigrescens
PARODYNST	230.7	24	Nardus stricta, Avenella flexuosa, Festuca airoides, Festuca nigrescens
PARODYNST	35.8	24	Nardus stricta, Avenella flexuosa, Festuca airoides, Festuca nigrescens
PARSCAAGR	33.8	27	Festuca stricta subsp. sulcata, Pilosella officinarum, Agrostis capillaris
PARSCAAGR	80.4	27	Festuca stricta subsp. sulcata, Pilosella officinarum, Agrostis capillaris
PARSCAAGR	74.8	27	Festuca stricta subsp. sulcata, Pilosella officinarum, Agrostis capillaris
PARSTEAIR	204.3	15	Festuca airoides, Nardus stricta
PARSTEAIR	191.9	15	Festuca airoides, Nardus stricta
PARSTEAIR	172.4	15	Festuca airoides, Nardus stricta
PARSTECSE	262.2	27	Carex sempervirens, Festuca airoides, Vaccinium myrtillus
PARSTECSE	347.3	27	Carex sempervirens, Festuca airoides, Vaccinium myrtillus
PARSTECSE	481.8	27	Carex sempervirens, Festuca airoides, Vaccinium myrtillus
RODBORBME	225.7	40	Agrostis capillaris, Festuca rubra
RODBORBME	262.8	40	Agrostis capillaris, Festuca rubra
RODBORBME	262.4	40	Agrostis capillaris, Festuca rubra
RODBORCEN	390.7	40	Nardus stricta

Site code	Biomass	Biodiversity	Dominant species
RODBORCEN	184.8	40	Nardus stricta
RODBORCEN	161.4	40	Nardus stricta
RODCEADES	568.1	19	Avenella flexuosa, Nardus stricta, Eriophorum (no herbar), Molinia caerulea
RODCEADES	622.1	19	Avenella flexuosa, Nardus stricta, Eriophorum (no herbar), Molinia caerulea
RODCEADES	481.7	19	Avenella flexuosa, Nardus stricta, Eriophorum (no herbar), Molinia caerulea
RODCEANST	208.2	20	Nardus stricta, Festuca nigrescens, Galium saxatile
RODCEANST	286.4	20	Nardus stricta, Festuca nigrescens, Galium saxatile
RODCEANST	248.3	20	Nardus stricta, Festuca nigrescens, Galium saxatile
RODGARCCU	139.0	6	Carex curvula, Juncus trifidus, Oreochloa disticha
RODGARCCU	69.6	6	Carex curvula, Juncus trifidus, Oreochloa disticha
RODGARCCU	110.2	6	Carex curvula, Juncus trifidus, Oreochloa disticha
RODGARDES	205.7	17	Nardus stricta, Deschampsia cespitosa, Galium saxatile
RODGARDES	217.1	17	Nardus stricta, Deschampsia cespitosa, Galium saxatile
RODGARDES	235.8	17	Nardus stricta, Deschampsia cespitosa, Galium saxatile
RODGARJUN	199.9	9	Carex curvula, Juncus trifidus
RODGARJUN	183.7	9	Carex curvula, Juncus trifidus
RODGARJUN	212.4	9	Carex curvula, Juncus trifidus
RODODDNST	540.7	7	Nardus stricta
RODODDNST	351.9	7	Nardus stricta
RODODDNST	581.7	7	Nardus stricta
RODPLANST	220.2	16	Nardus stricta, Agrostis capillaris, Galium saxatile
RODPLANST	490.9	16	Nardus stricta, Agrostis capillaris, Galium saxatile
RODPLANST	505.5	16	Nardus stricta, Agrostis capillaris, Galium saxatile
RODPRIFNI	311.1	16	Deschampsia cespitosa, Festuca nigrescens, Nardus stricta
RODPRIFNI	413.2	16	Deschampsia cespitosa, Festuca nigrescens, Nardus stricta
RODPRIFNI	384.7	16	Deschampsia cespitosa, Festuca nigrescens, Nardus stricta
RODSAUNST	206.7	17	Nardus stricta, Galium saxatile, Anthoxanthum odoratum, Vaccinium myrtillus, Ligusticum mutellina
RODSAUNST	271.6	17	Nardus stricta, Galium saxatile, Anthoxanthum odoratum, Vaccinium myrtillus, Ligusticum mutellina
RODSAUNST	217.0	17	Nardus stricta, Galium saxatile, Anthoxanthum odoratum, Vaccinium myrtillus, Ligusticum mutellina

Soil samples

We collected soil samples from the Parang mountains (14 sites), while from each sites we collected in 3 repetitions. Soil cores that will be used for measuring parameters were sieved and dried at room temperature, while roots were extracted by tap water and dried for further laboratory analyses.



Transportation and drying the soil and root samples from the sites

Temperature data loggers

All sites were equipped with Hobo UA-001-64 data loggers, each site with two loggers to avoid unexpected lost material or damaged.



Working in the experimental long-term monitoring sites, using the equipment to install loggers and collect biomass

Teabags incubation

According to the protocol, we installed 5 Rooibos tea bags in each site, close to the wood stick of one of the loggers to better retrieve them.



Burring the tea bags into the ground, within the root area to measure the lost material by decomposition capacity of the ecosystem

Conclusions

The first goal of the project was accomplished by installing nice long-term monitoring sites in the Romanian mountains. The three mountain ranges (Parang, Rodna, Apuseni) will facilitate an excellent way of empirically measuring the effect of climate change on high mountain ecosystems.

In the next year (2019) of the project, **we plan to visit the sites in order to retrieve the data** from the temperature loggers, to replace their batteries, retrieve the teabags and re-measure their weight. The study of these ecosystem components will be an invaluable scientific resource.