JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

VolkswagenStiftung

AMIES II - Midterm Meeting

Giessen, Rauischholzhausen in May 2016

Scenario Development for Sustainable Land Use
in the Greater Caucasus, Georgia

Project unit C1

Presentation title: G. Tedoradze, M.Sc. (Institute of Botany, ILIA): Phytodiversity and biomass production at steep slopes

Center for International Development and Envrionmental Research

Ivane Javakhishvili Tbilisi State University

Ilia State University

Agricultural University of Georgia

Research aims of the Project unit C1

My work is carried out within the international project AMIES II - Scenario development for sustainable land use in the Greater Caucasus, Georgia

1. The general goal of my work is analyzing the relations between patterns of phytodiversity and productivity / biomass potentials at the patch scale
2. Methods used: vegetation sampling, field-spectrometry, and biomass harvesting: relations between site productivity and plant functional diversity of the grassland swards
3. The expected results: improved vegetation modelling and estimates of carrying capacities

Aims of my PhD thesis (C1)

Specifically, we quantitatively analyzed the following relationships:

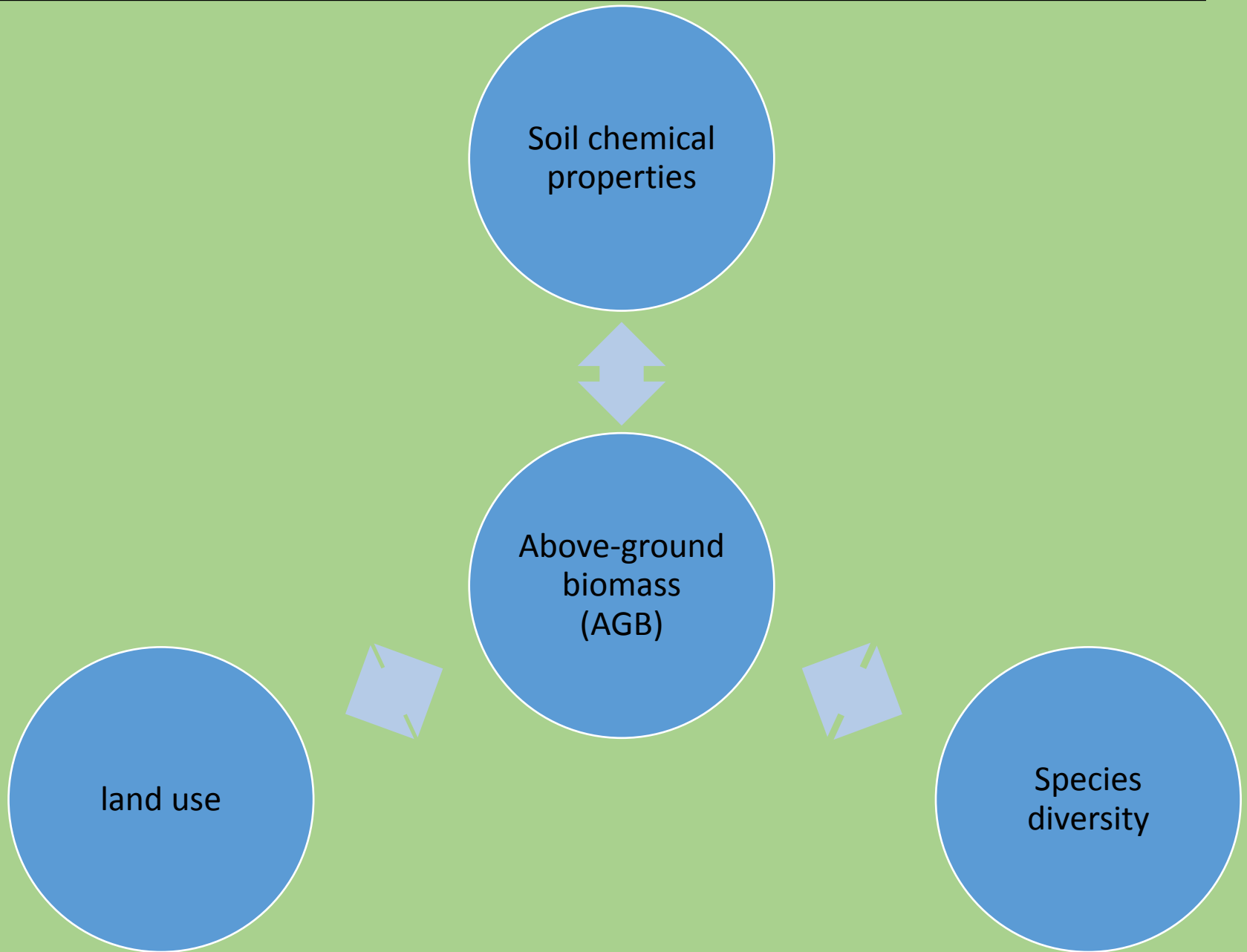
a) the relations between soil chemical parameters and species diversity of grassland on steep mountain slopes,

b) the relation between species diversity and *Above-ground biomass (AGB)* of grasslands on steep mountain slopes,

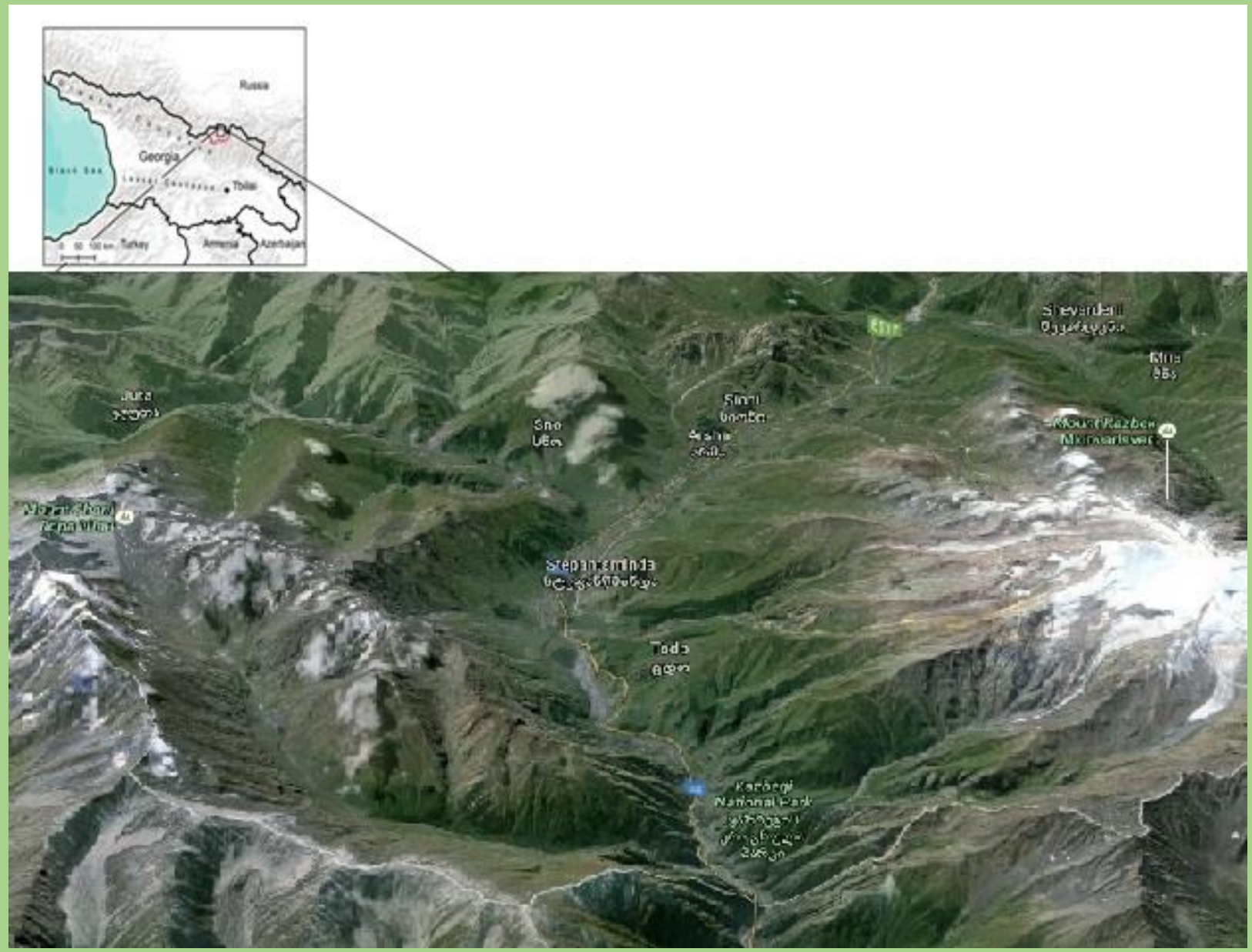
c) the relations between soil chemical properties and *Above-ground biomass (AGB)* of grasslands on steep mountain slopes,

d) the relations between land use and *Above-ground biomass (AGB)* of grasslands on steep mountain slopes

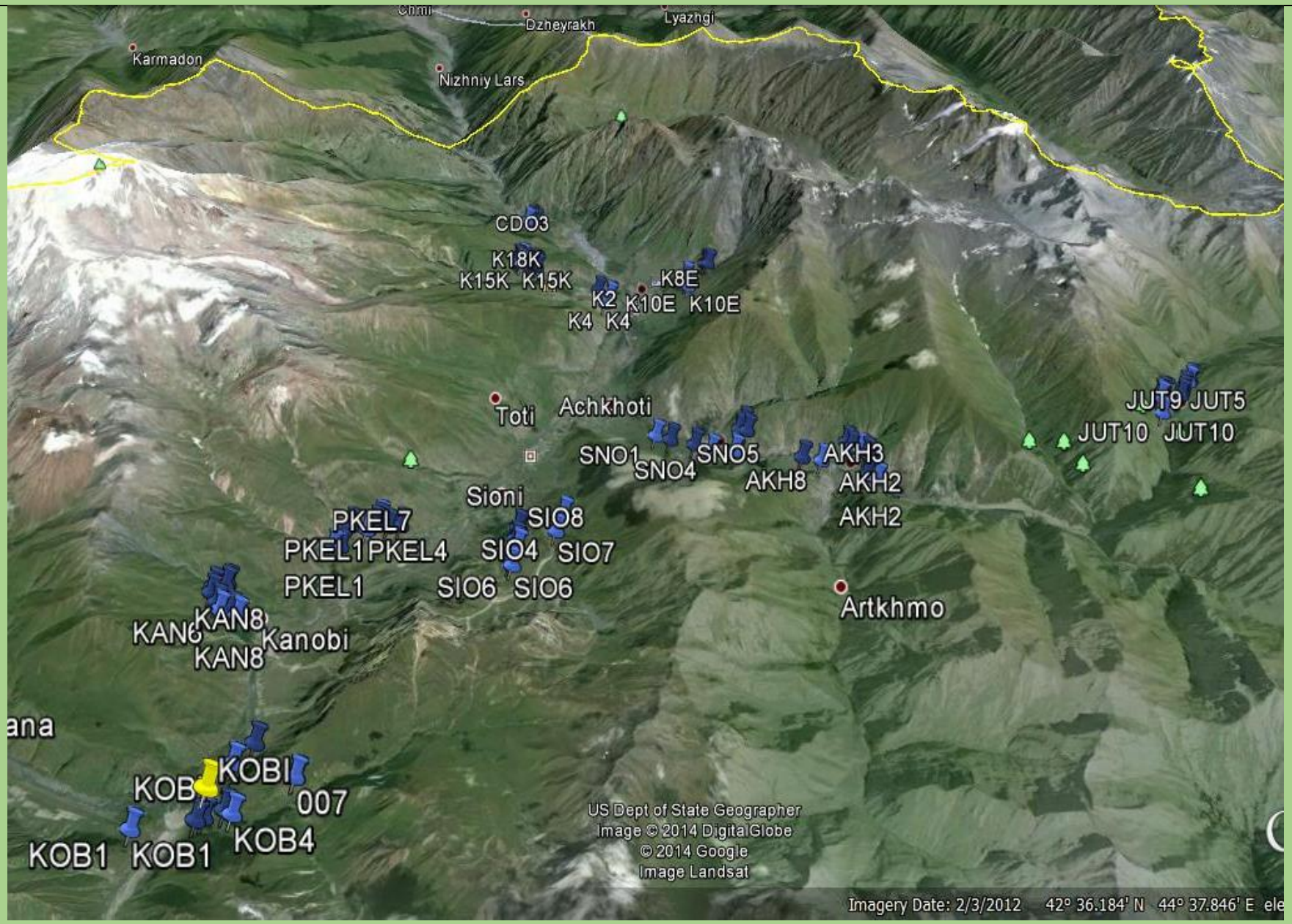
The flowchart of my study



Location of study area



Study sites in the Kazbegi region



Vegetation sampling

In total, I sampled 83 plots in Kazbegi, during the summer season (2014-2015).

	Name of the village (study site)	Number of plots
1.	Khanobi	8
2.	Sioni	8
3.	Kobi	8
4.	Kazbegi	18
5.	Sno	8
6.	Akhaltsikhe	9
7.	Pkhelshe	9
8.	Juta	10
9.	Tsdo	5

Standardized 25 m^2- plots, Braun-Blanquet scale

Villages where I took the plots

Tsdo

Juta

Sno

Relevant habitat types for data sampling

- Steep (>10°) meadows in proximity to settlements, northern slope
- Steep (>10°) meadows in proximity to settlements, southern slope
- Steep (>10°) pasture in proximity to settlements, northern slope
- Steep (>10°) pasture in proximity to settlements, southern slope

- montane
- subalpine
- alpine
- subnival
- nival

- **Elevation (m above sea level)**

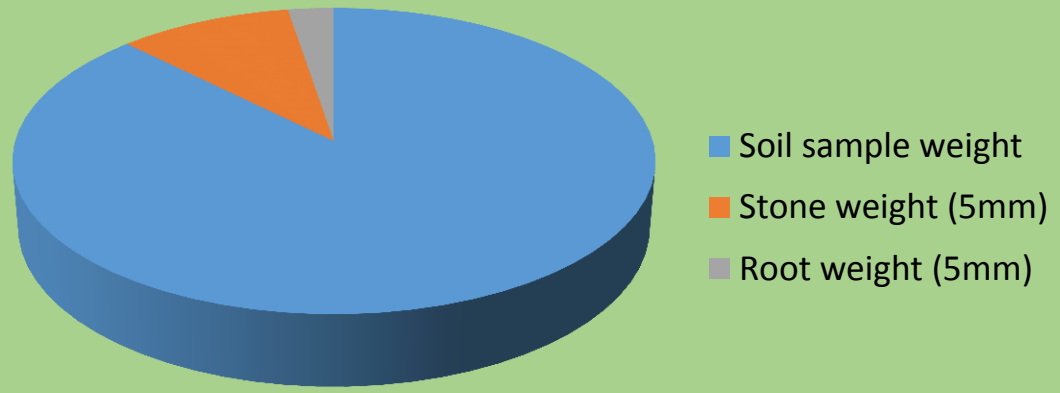
1000 – 1750 m
1750 - 2500 m
2500 - 3000 m
3000 - 3600 m
> 3600 m

- **1750-2317 m**
- **Slope (degree)**
- **Steep, > 10°**
- **Aspect (N, S)**

The plots were chosen according to the slope, aspect and the distance to the settlement (at 900 m away)

Soil sampling

Besides the plant sociological study there were taken samples of soil from each plot.



Soil corer with a diameter of 3 cm.

Soil sample weight	Stone weight (5mm)	Root weight (5mm)
46.309	5.263	1.382

Field work in Kazbegi

Biomass sampling, separating and draying

Harvesting of biomass took place in the summer of 2015-2016. Above-ground biomass was harvested with a scissors.

The resulting harvested vegetation is collected, sorted (Grass, Herbs, Legumes), dried in an oven and then weighed.

Indicator species

In a first step, an indicator species analysis was performed for the different exposition (S, N)

		Frequency		
		Northern	**Southern**	
Northertn slopes	**Indicator value (>14)**	**n=43**	**n=39**	***P***
Rhinanthus minor	49.1	81	51	0.0108
Agrostis planifolia	45.3	77	56	0.0472
Ranunculus oreophilus	43.6	67	38	0.0096
Pimpinella rhodantha	53.2	58	5	0.0002
Polygonum carneum	53.5	53	0	0.0002
Southern slopes				
Medicago glutinosa	58	51	90	0.0006
Trifolium alpestre	40.4	40	64	0.019
Festuca ovina	40	33	64	0.0132
Koeleria luerssenii	40.7	28	56	0.0032
Salvia nemorosa	38.1	5	41	0.0002

In total, the number of indicator species for Northern slopes was 18, and for Southern slopes 16

Indicator species for Northern slopes

Polygonum carneum

Rhinanthus minor

Agrostis planifolia

Indicator species for Southern slopes

Trifolium alpestre

Medicago glutinosa

Koeleria luerssenii

Grazing in Kazbegi

The major grazers are caws, horses and sheep

Indicator species for Pastures and Meadows

		Frequency (%)		
		Pasture	Meadow	
Pasture	**Indicator value(>14)**	**n=49**	**n=33**	**P**
Campanula collina	53.3	**82**	55	0.004
Festuca varia	37	**47**	15	0.0028
Cirsium obvalatum	33.4	**51**	24	0.0458
Silene ruprechtii	36.3	**55**	30	0.0378
Astragalus captiosus	29.1	**37**	9	0.0112
Carex humilis	25.6	**31**	9	0.0186
Dianthus cretaceus	25.3	**31**	9	0.023
Galium album	23.8	**29**	6	0.0156
Silene linearifolia	18.4	**18**	0	0.009
Euphrasia caucasica	16.3	**16**	0	0.0192

		Frequency (%)		
		Pasture	Meadow	
Meadow	**Indicator value(>14)**	**n=49**	**n=33**	**P**
Trifolium ambiguum	48.3	61	**82**	0.031
Pastinaca armena	41.6	47	**70**	0.038
Trifolium alpestre	41.2	43	**64**	0.0204
Koeleria luerssenii	39.6	37	**61**	0.0134
Leucanthemum vulgare	37.9	16	**48**	0.0008
Polygala transcaucasica	37.8	16	**45**	0.0018
Vicia purpurea	36.7	27	**52**	0.0068
Seseli transcaucasicum	36.7	4	**42**	0.0002

In total, there were 10 indicator species in the pastures and 19 in the meadows

Indicator species for Meadows

Bromopsis variegata

Trifolium alpestre

Trifolium ambiguum

Indicator species for Pastures

Veratrum lobelianum

Astragalus captiosus

Sempervivum transcaucasicum

Cirsium obvalatum

Indicator species under different management

		Frequency (%)			
		Pasture	**Meadow**		
Pasture overgrazed	**Indicator value (>14)**	**n=17**	**n=5**	**n=11**	P
Dianthus cretaceus	46.6	**65**	0	18	0.001
Sempervivum transcaucasicum	40.7	**47**	0	0	0.002
Astragalus captiosus	32.3	**65**	20	18	0.0114
Silene ruprechtii	28.2	**82**	20	64	0.0418
Taraxacum officinale	22.6	**35**	0	9	0.04
Pasture lass grazed					
Trifolium alpestre	31.9	0	0	**27**	0.0208
Thalictrum collinum	27.3	12	20	**82**	0.0112
Hypericum caucasicum	15.2	0	0	**18**	0.0332
Meadow lass grazed					
Ranunculus oreophilus	40.8	24	**100**	64	0.002
Campanula trautvetteri	30.4	6	**40**	0	0.021
Leucanthemum vulgare	30.2	100	**100**	100	0.0282
Astrantia trifida	29.2	0	**40**	9	0.0104
Bromopsis variegata	28	6	**60**	18	0.0164

In total, there were 9 indicator species in the overgrazed pastures, 3 in moderately grazed pastures and 10 in the meadows (less grazed)

Correlation between soil chemical (N, C, C/N, K, P, Mg,) properties and AGB.

Biomass type	mg.Mg.kg.Bodern	mg.P.kg.Bodern	mg.K.kg.Bodern	N..Value.	C..Value.	C/N
Grass..t.ha.	0.325946	0.329146	0.1257783	0.299646	0.268386	*0.044378*
Herbs.t.ha.	0.38656	0.21721	0.3396334	0.28447	0.30146	*0.329405*
Legumes..t.ha.	-0.0509	-0.08158	0.02628804	-0.1729	-0.17574	*-0.04351*
X.t.ha.	*0.371294*	*0.256603*	*0.28485615*	0.234869	0.224665	*0.190799*

Analyses of correlation between soil chemical properties and AGB of Legumes, Herbs and Grasses, the best coefficients were found between Herbs and Mg, K, P, N, C, C/N in soil (0.38, 0.34, 0.22, 0.28, 0.3, 0.32, 0.04) also correlation was high between Grasses and Mg, K, P, N, C, C/N in soil (0.32, 0.12, 0.32, 0.3, 0.27), whilst correlation was considerably weaker with Legumes (-0.05, 0.02, -0.08, -0.17, -0.17, -0.17)

Correlation between AGB and Richness

	Grasses t/h	Herbs t/h	Legumes t/h	X t/ha
Species richness	*0.345619*	*0.258019*	*0.078075577*	*0.377388*

Correlation is high between the Richness and AGB (0.37).

The correlation between Richness separately with Legumes, Herbs, Grass were as follows: 0.07, 0.25, 0.34;

Correlation between richness and other important variables

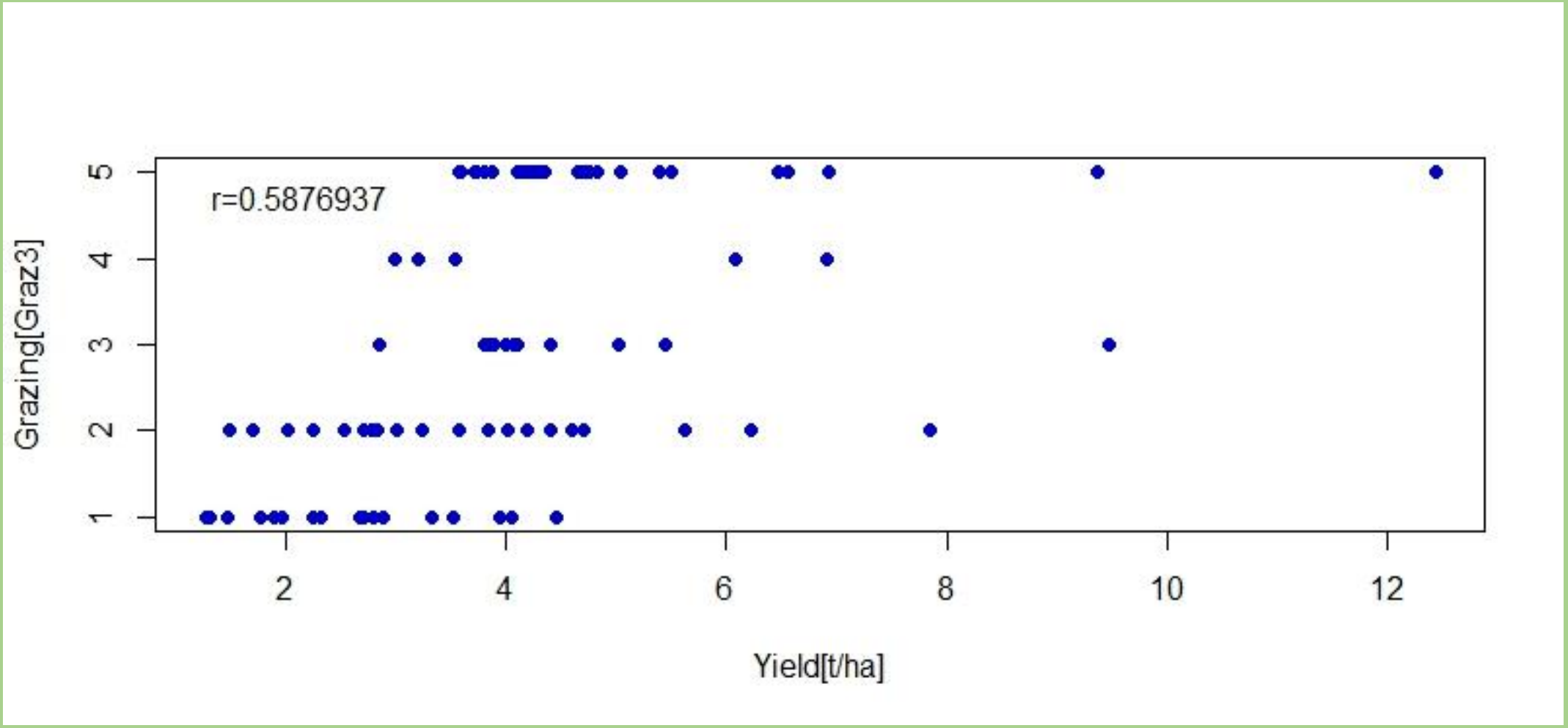
Species richness negatively correlated with Slope degree, Cover bare rock, Open soil abundance

Correlation was high between the soil chemical (N, C, C/N, K, P, Mg,) variables and species richness.

	Species richness
Slope degree	-0.30387
Cover bare rock	-0.24744
Open soil abundance	-0.47035
N	0.309169
C	0.308352
C/N	0.263107
K	0.32412
P	0.369796
Mg	0.336815

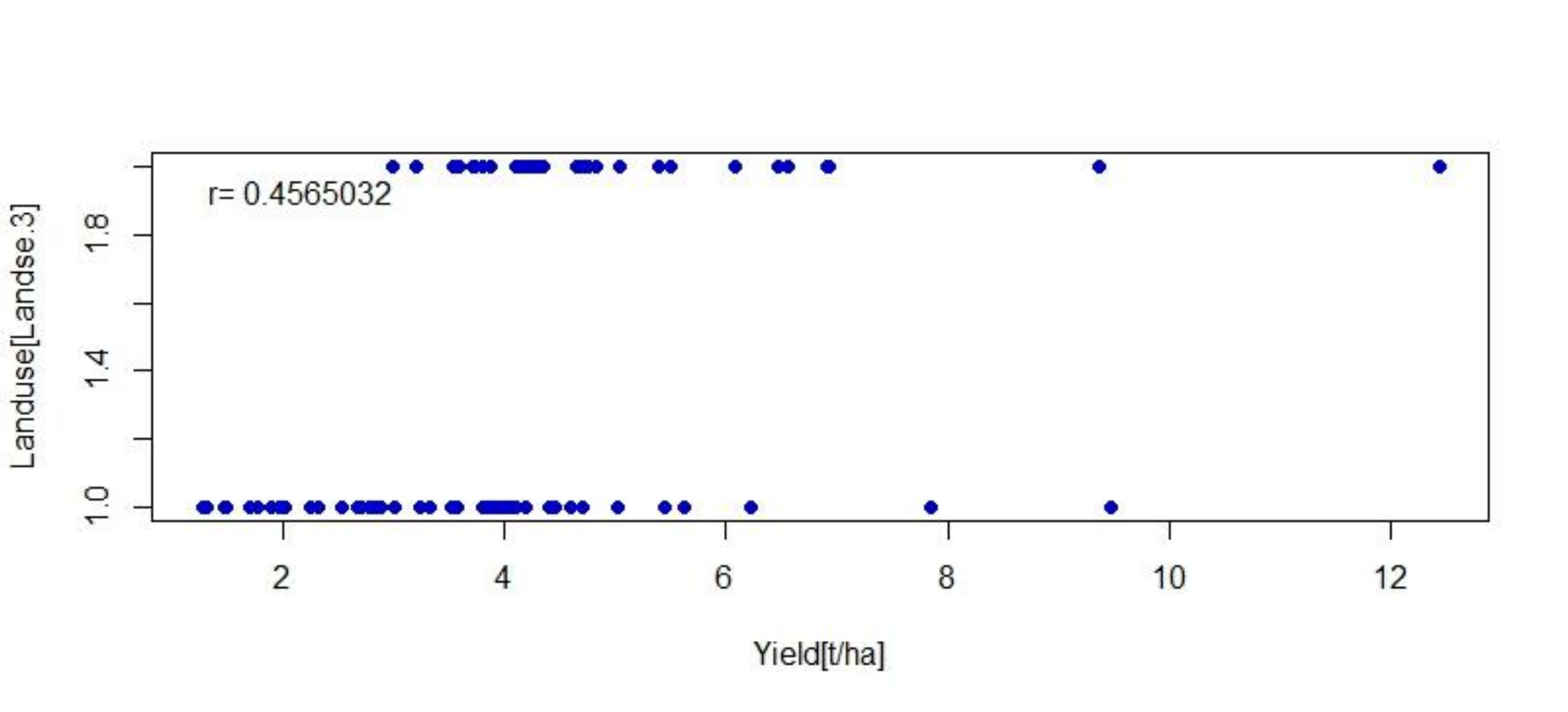
	Species richness
Slope degree	*-0.30387*
Cover bare rock	*-0.24744*
Soil depth	*0.240188*
Water content	*0.199021*
N	*0.309169*
C	*0.308352*
C/N	*0.263107*
K	*0.32412*
P	*0.369796*
Mg	*0.336815*
t/ha	*0.365524*
PHdistwhat1	*-0.23151*
Open soil abundance	*-0.47035*
Richness	*1*
Simpson	*0.41366*
Cw5	*0.345182*
dvi	*0.524018*
evi	*0.485658*
msavi	*0.459359*
ndvi	*0.523961*
NIR red2	*0.57313*
NIR rededg	*0.524018*
savi0-5	*0.495969*
sr800550	*0.541933*
wdrvi	*0.523357*
arvi22	*0.519512*

Correlation between AGB and grazing intensity



As the figure shows, grazing strongly correlated with AGB (0.58).

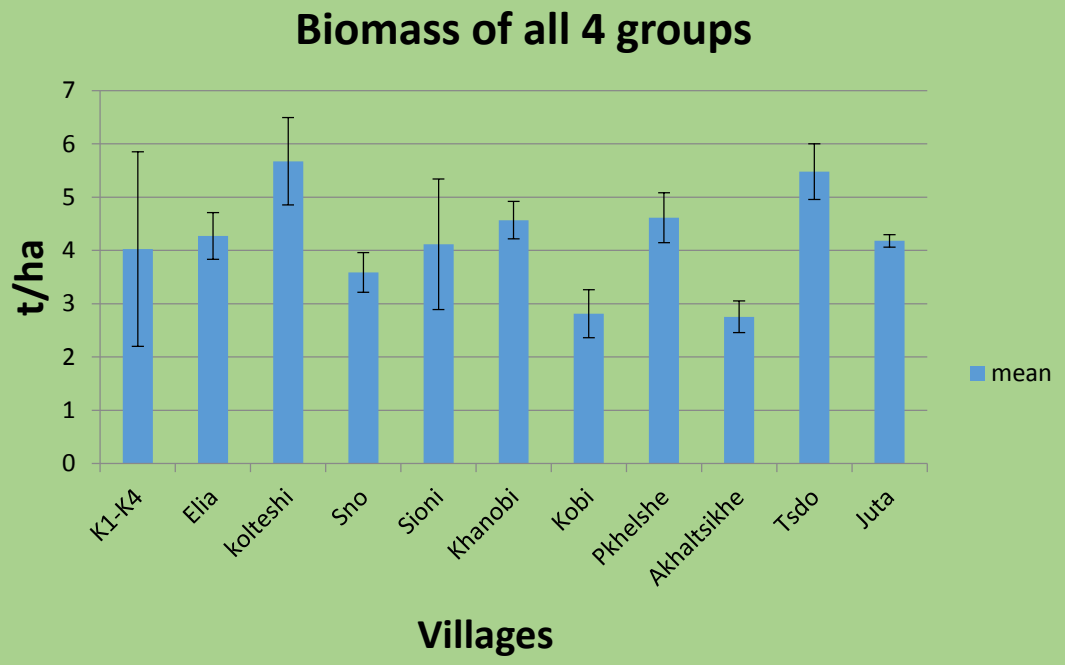
Correlation between AGB and land use



As the figure shows Land use strongly affected AGB (r = 0.45), in a manner of “switch”.

AGB for each village t/ha

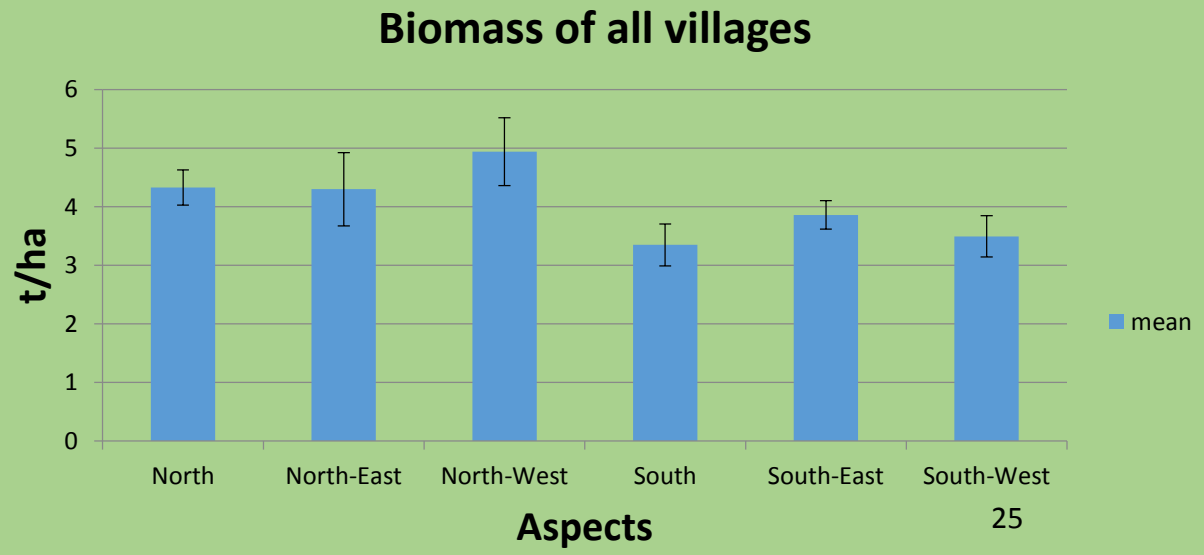
I calculated standard errors and mean AGB for each villages, aspects, habitat type and land use.



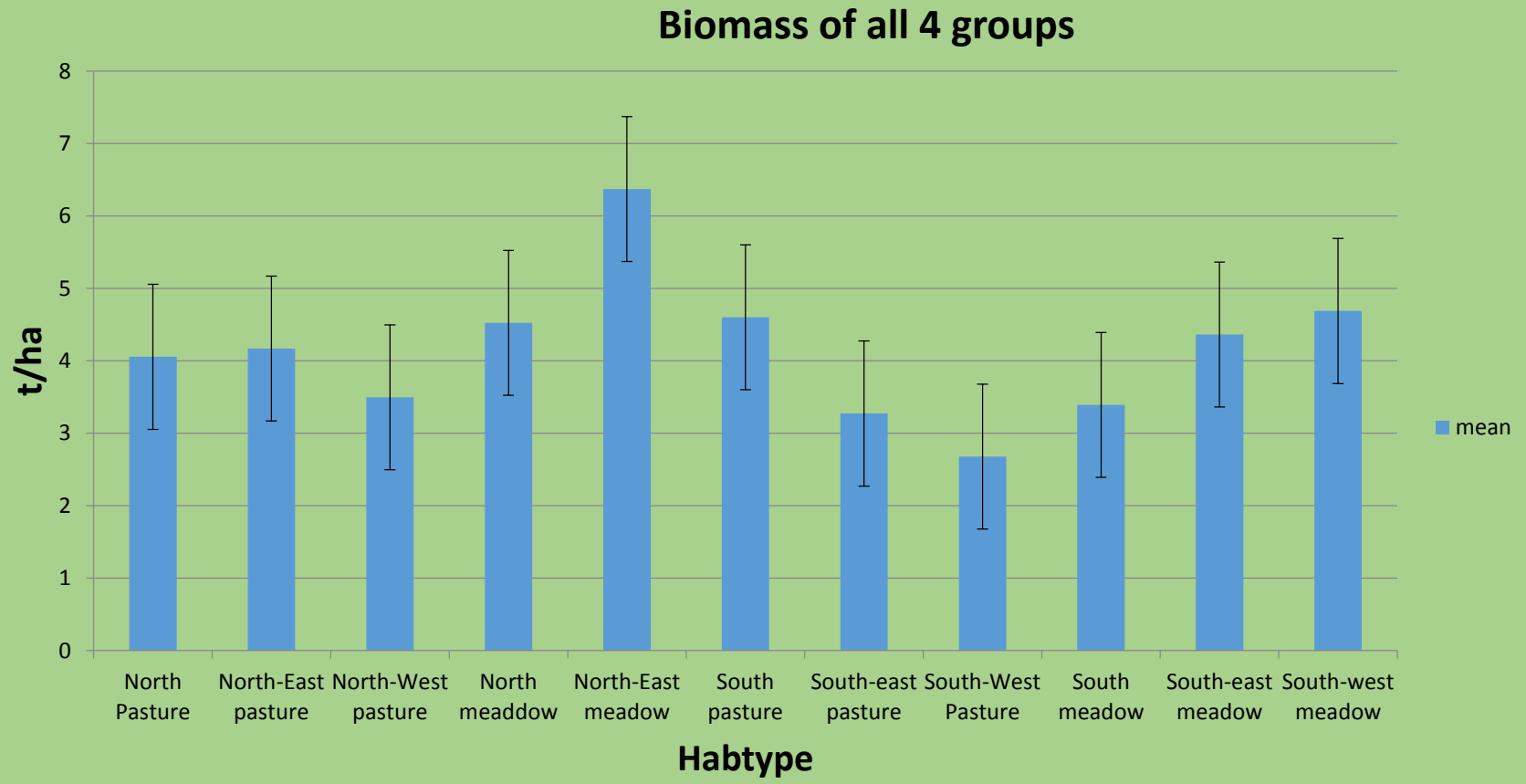
Mean AGB values with corresponding SE (error bars) are shown for each village, all plots with different aspect, habitat type and land use combined. AGB was the lowest in Kobi and Akhaltsikhe, whilst AGB was the highest in Kolteshi (Kazbegi), Tsdo and Khanobi. We can see also that standard error was largest in K1-K4 and Sioni, in both cases probably caused harvesting from the enclosed meadow plots.

AGB was highest on NW aspects, then on N and NE aspects, and the lowest AGB was observed on S aspect.

AGB for each aspects t/ha

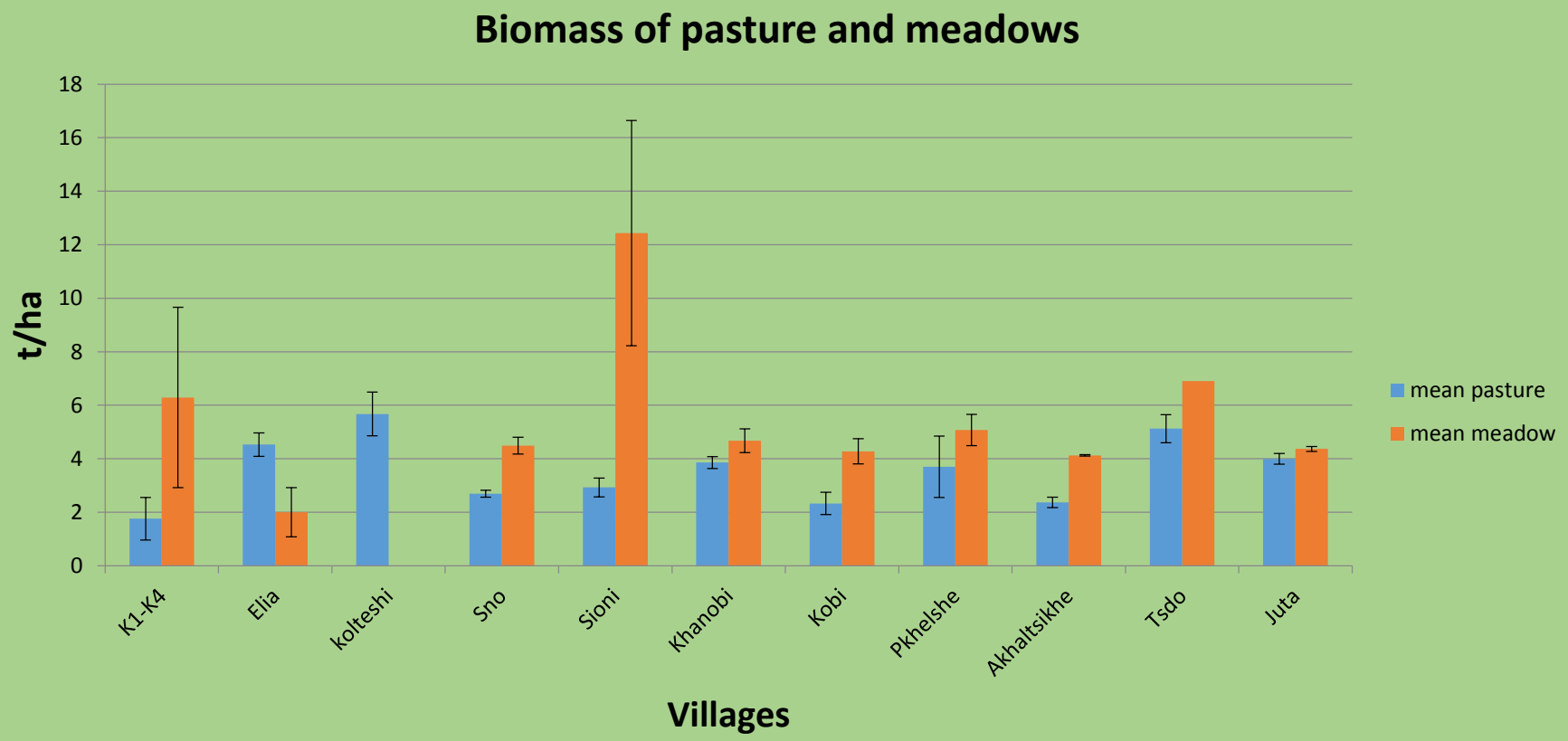


AGB by aspects and land use t/ha



As the figure shows, AGB was highest on the NE meadows, whereas on the SW pastures it was the lowest (mean values ± SE).

AGB pasture and meadow t/ha



AGB was generally and without exception higher on the meadows as compared to the pastures.

Assessment of the preliminary results.

• Most frequent species were *Dianthus cretaceous, Sempervivum transcaucasicum, Astragalus captiosus, Festuca varia, Cirsium obvalatum* (pastures); *Trifolium ambiguum, Pastinaca armena, Trifolium alpestre, Koeleria luerssenii, Leucanthemum vulgare, Ranunculus oreophilus, Bromopsis variegata* (meadows). As we can see the meadows is rich in weeds (*Leucanthemum, Ranunculus*), which can be one proof of the strong prehistoric herbivory pressure.

• The lowest AGB values were found on S and SW aspect pastures (the villages of Kobi and Akhaltsikhe), whilst the highest AGB values were on NW and NE hay meadows (Kolteshi (Kazbegi), Tsdo and Khanobi).

• The soil chemical (N, C, C/N, K, P, Mg,) properties correlated with both Richness and AGB.

• The biomass of Legumes did not correlate with the amount of Mg, K, P, N, C, C/N in the soil.

• Our results confirm that land use (grazing) affects strongly both the AGB and species richness.

• The analysis also showed that species richness correlates negatively with Slope degree (-0.3), Cover bare rock (-0.25), Open soil abundance (-0.47).

All analyses were performed with the software packages:
Version 0.99.489 – © 2009-2015 RStudio, Inc.

Soil chemical analyses were carried out by the Institute of Soil Science and Soil Conservation at Giessen University.

Harvested vegetation (Grass, Herbs, Legumes), dried in an oven and then weighed at Giessen University.

Thank you for your attention!

giorgi.tedoradze.2@iliauni.edu.ge

National statistics office of Georgia