

Charles University in Prague

Faculty of Science

Institute for Environmental Studies



Human influence on plant species diversity in the
Complex Paramo de Santurban (Colombia)

Antropogenní vliv na diverzitu rostlin v komplexu Páramo de Santurban
(Kolumbie)

Master thesis

Author: Bc. Diana Libeth Aparicio Vasquez
Advisor: doc. RNDr. Petr Sklenář, Ph.D
Consultant: Ing. Luboš Matějček, Dr.

August 2011

Content

Acknowledgements	1
Proclamation	2
Summary	3
Abstrakt	4
Chapter 1 - Introduction	6
Chapter 2 - Literature Review	8
2.1. Climatic characteristic of the paramo ecosystem	10
2.2. Characteristic of the soils	12
2.3. Paramo vegetation	12
2.3.1. Evolution of paramo flora	14
2.3.2. Physiognomy of paramo vegetation	14
2.3.3. Phytogeography and Origins	18
2.4. Human in the paramo environment	19
2.5. Impact of agricultural practices on paramo ecosystem	22
2.5.1. The effects of cattle grazing and burning on paramo vegetation	22
2.5.2. The effects of cattle grazing and burning on soil properties	24
Chapter 3 - Methods	25
3.1. Study site	25
3.2. Sampling and data analyses	26
Chapter 4 - Results	28
4.1. General floristic diversity	23
4.2. Intensity of human impact	28
4.3. Human influence on vegetation	31
4.4. Human influence on species diversity	35
Chapter 5 - Discussion	41
Conclusion	47
Literature cited	48

List of figures

Geographic delimitation of the paramo ecosystem.....	9
Overall climate of paramo.....	11
Overall relative importance of each plant species versus its rank.....	30
Histogram of the number of cows.....	34
Histogram of the number of cow droppings.....	34
Distance to path within each altitudinal interval.....	35
Histogram of the distance from the center of the sample plot to the nearest path.....	35
Species composition presented in an ordination diagram (DCA).....	37
Relationship between vegetation, environmental and management data (CCA).....	39
Linear regression plot between altitude and Shannon-Wiener index	40
Linear regression plot between altitude and species richness.....	41

List of tables

Vascular plant diversity in tropical alpine floras of the world.....	13
Fifteen largest families and genera of paramo flowering plants.....	13
Species richness of paramo genera with tropical, north temperate, and south temperate origin.....	18
The most frequent species in Santurban paramo.....	28
Important plant species in the Santurban paramo.	29
Important plant families in the paramo of Santurban.....	31
The most important herbaceous and woody species in the Santurban paramo.....	32
Plant life forms at páramo de Santurban.	32
Intensity of human impact through altitudinal gradient.....	33
Distribution of cows and cow droppings within the altitudinal gradient.....	34

Appendix 1

Vegetation data

Species	Mean coverage (%)	Relative frequency
<i>Lachemilla Orbiculata</i>	9.6	0.018
<i>Hypericum Mexicanum</i>	1.7	0.032
<i>Trifolium repens</i>	8.4	0.008
<i>Hypochaeris sessiliflora</i>	2.6	0.034
<i>Geranium multiceps</i>	1	0.025
<i>Taraxacum officinale</i>	1.9	0.005
<i>Gnaphalium sp.</i>	1.3	0.012
<i>Anthoxantum odoratum</i>	12.2	0.032
<i>Paspalum bosplandianum</i>	4.5	0.022
<i>Noticastrum marginatum</i>	1.9	0.034
<i>Acaena cylindristachya</i>	1.8	0.041
<i>Nertera granadensis</i>	1.2	0.007
<i>Gamochaeta americana</i>	1	0.016
<i>Rumex acetocella</i>	7	0.018
<i>Espelesiopsis santanderensis</i>	9.9	0.023
<i>Orthosanthus chimborasensis</i>	6.6	0.023
<i>Sisyrinchium trinervi</i>	1.1	0.012
<i>Ageratina sp1</i>	2	0.002
<i>Castilleja integrifolia</i>	1.4	0.013
<i>Bidens andicola</i>	1.6	0.018
<i>Hypochaeris radicata</i>	2	0.011
<i>Equisetum bogotensis</i>	1	0.002
<i>Bacharis tricuneata</i>	2.5	0.029
<i>Hypochaeris sp.</i>	0.8	0.003
<i>Cerastium arvense</i>	0.7	0.003
<i>Acaena elongata</i>	2.2	0.006
<i>Ageratina sp2</i>	1.8	0.009
<i>Plantago monticola</i>	1.7	0.02
<i>Lachemilla hispidula</i>	0.8	0.003
<i>Oxalis tuberosa</i>	1.4	0.005
<i>Calamagrostis effusa</i>	5.7	0.032
<i>Lupinus bogotensis</i>	1.7	0.004
<i>Hypericum laricifolium</i>	2.5	0.01
<i>Aciachne pulvinata</i>	1.6	0.019
<i>Hieracium Frigidum</i>	1.4	0.006
<i>Halenia sp.</i>	1.6	0.022
<i>Gentianella Corymbosa</i>	1.3	0.008
<i>Bartsia sp.</i>	1	0.014
<i>Arcytophyllum muticum</i>	1.6	0.014
<i>Plantago sp</i>	2.1	0.006
<i>Oreobolus sp</i>	1.9	0.009
<i>Paepalanthus</i>	2.7	0.005
<i>Rynchospora macrochaeta</i>	1.9	0.008
<i>Espeletia Conglomerata</i>	2	0.003
<i>Agrostis trichodes</i>	1.9	0.027
<i>Aira sp</i>	2	0.008
<i>Achyrocline lehmannii</i>	1.6	0.016
<i>Pernettya Prostrata</i>	1.7	0.014
<i>Bacharis Prunifolia</i>	4.3	0.015
<i>Hypericum sp1</i>	2.5	0.007
<i>Stachys elliptica</i>	1.5	0.003

<i>Conyza phylaginoides</i>	1	0.003
<i>Bidens triplinervia</i>	0.8	0.005
<i>Juncus sp</i>	2.2	0.003
<i>Viola humilis</i>	3	0.001
<i>Carex sp.</i>	2.1	0.008
<i>Ranunculus peruvianus</i>	1.6	0.007
<i>Avena</i>	1.7	0.003
<i>Lachemilla sp1</i>	2.2	0.004
<i>Gamochaeta purpurea</i>	1	0.002
<i>Agrostis sp1</i>	0.5	0.001
<i>Papa Lila</i>	3	0.001
<i>Salvia killipiana</i>	0.5	0.001
<i>Oxalis sp</i>	1.5	0.003
<i>Agrostis sp2</i>	1.8	0.002
<i>Gaultheria erecta</i>	1.9	0.01
<i>Senecio formosum</i>	1.3	0.003
<i>Hiracium avile</i>	1	0.009
<i>Lobelia nana</i>	0.9	0.003
<i>Hypericum selaginoides</i>	2.7	0.006
<i>Valeriana rigida</i>	1.8	0.004
<i>Hypericum strictum</i>	5	0.01
<i>Agrostis sp3</i>	0.5	0.001
<i>Poa sp</i>	3	0.002
<i>Oreomyrrhis andicola</i>	1	0.001
<i>Lachemilla sp1</i>	1.8	0.004
<i>Gentiana sedifolia</i>	0.8	0.002
<i>Chusquea scandes</i>	3	0.002
<i>Arcytophyllum nitidum</i>	4.3	0.013
<i>Loricaria sp.</i>	3	0.001
<i>Niphogeton sp1</i>	0.5	0.001
<i>Lucilia sp</i>	0.5	0.001
<i>Disterygma sp</i>	2	0.003
<i>Puya sp</i>	2.3	0.003
<i>Lachemilla polylepis</i>	2	0.003
<i>Eryngium humilis</i>	1.3	0.005
<i>Halenia sp2</i>	2	0.003
<i>Carex sp2</i>	1.7	0.003
<i>Stipa sp1</i>	2.7	0.006
<i>Aa sp1</i>	3	0.001
<i>Calamagrostis recta</i>	2.4	0.006
<i>Stipa sp2</i>	1	0.003
<i>Stipa sp3</i>	1	0.001
<i>Diplostephium revolotum</i>	1.7	0.003
<i>Ageratina sp3</i>	2	0.002
<i>Belloa sp</i>	2	0.007
<i>Oritrophium limnophyllum</i>	3	0.001
<i>Gnaphalium sp.</i>	0.9	0.004
<i>Castilleja sp1</i>	1.6	0.005
<i>Castilleja sp2</i>	3	0.004
<i>Calceolaria sp</i>	3	0.003
<i>Pentacalia Ramificada</i>	3	0.002
<i>Bromus sp</i>	2.2	0.004
<i>Oritrophium peruvianus</i>	1.7	0.003
<i>Carex sp3</i>	1	0.002
<i>Niphogeton sp2</i>	0.6	0.003
<i>Disterygma sp2</i>	1.4	0.004
<i>Diplostephium sp</i>	0.8	0.002
<i>Cyperus sp</i>	1	0.001
<i>Cortadeira colombiana</i>	1	0.001
<i>Pentacalia sp</i>	1	0.001

<i>Niphogeton sp3</i>	1	0.002
<i>Holcus Lanatus</i>	1	0.002
<i>Geranium sp1</i>	0.9	0.006
<i>Festuca sp.</i>	3	0.001
<i>Poa sp2</i>	3	0.002
<i>Cebada</i>	3	0.001
<i>Poa sp4</i>	0.5	0.001
<i>Arracacha</i>	1	0.001
<i>Gnaphalium polycephalum</i>	0.8	0.002
<i>Gnaphalium paramuro</i>	1.3	0.009
<i>Geranium santanderensis</i>	0.9	0.003
<i>Gnaphalium antenaroides</i>	2	0.003
<i>Festuca sp2</i>	1	0.001
<i>Poa sp5</i>	1	0.001
<i>Castilleja sp3</i>	1	0.001
<i>Diplostephium rupicola</i>	2.7	0.005
<i>Niphogeton sp4</i>	1	0.003
<i>Erigeron paramensis</i>	2	0.002
<i>Geranium sp2</i>	3	0.001
<i>Agrostis boyacensis</i>	1	0.002
<i>Odontoglossum sp.</i>	1	0.001
<i>Vaccinium sp.</i>	2.8	0.007
<i>Pernettya sp</i>	3	0.002
<i>Pentacalia andicola</i>	1	0.001
<i>Hypoxis sp</i>	1	0.001
<i>Pentacalia ledifolia</i>	2	0.001
<i>Hypericum sp2</i>	1	0.001
<i>Aragoa</i>	1	0.001
<i>Miconia suma</i>	2	0.001
<i>Quercus</i>	2	0.001

Appendix 2

Environmental data

Appendix 3

Management data

Appendix 4

Species diversity data

Releve	cow droppings (10m)	Altitude (m)	Exposition	Slope (°)	Azimut	Rocks (%)	Bare	Vegetation (%)
V32361	10	3622	S	20	200	2	0	98
B323651	7	3619	SE	20	160	0	2	98
B323652	12	3646	SW	30	250	3	12	85
B363812	4	3610	S	5	190	25	3	72
B 49	2	3648	S	25	170	1	30	69
B36384	0	3682	N	10	70	0	0	100
B363810	7	3623	S	20	160	0	5	95
B323650	5	3654	NE	5	80	5	10	85
B36387	5	3617	E	50	85	0	10	90
B323643	4	3498	N	20	60	0	5	95
B323629	10	3502	W	10	250	0	0	100
B323635	10	3599	E	45	70	0	3	97
B323642	10	3429	W	5	270	0	0	100
B32365	5	3484	N	30	20	0	25	75
B323632	12	3492	SW	30	240	0	10	90
B32366	4	3460	NE	5	60	0	40	60
B323613	12	3410	W	5	310	0	5	95
B323612	7	3368	W	5	240	0	5	95
B323641	7	3375	NE	30	70	0	0	100
B323610	4	3472	NE	10	50	0	90	10
B323638	0	3848	NE	45	40	0	5	95
B383	3	3752	E	50	120	0	7	93
B384	3	3730	SE	10	130	5	10	85
B36386	0	3715	SE	10	100	5	5	90
B36389	7	3723	S	5	180	0	15	85
B36383	5	3723	S	15	190	5	5	90
B36381	12	3588	E	5	80	0	10	90
6	10	3575	E	5	90	0	0	100
B323625	7	3556	W	20	240	0	5	95
B323647	4	3542	NE	10	60	5	20	75
B32369	10	3425	S	5	150	0	5	95
B323614	12	3507	SW	5	210	0	15	85
B323640	12	3537	SW	40	240	0	0	100
B323623	12	3498	S	5	180	0	5	95
B32362	5	3525	N	10	20	0	10	90
B323630	10	3540	S	5	210	8	5	87
B323615	3	3599	NE	15	70	0	20	80
B323628	0	3603	E	10	100	0	25	75
B323648	0	3594	N	10	10	0	0	100
B323611	0	3670	E	20	100	0	5	95
B382	0	3614	NE	30	60	0	5	95
B363815	0	3956	NW	35	330	40	0	60
B323621	0	3818	E	25	120	0	0	100
B36385	0	3764	E	20	120	0	0	100
B363818	5	3575	SW	10	210	0	5	95
B323620	8	3602	E	0	90	0	5	95
B323634	4	3597	N	2	30	0	5	95
B323636	15	3467	NE	2	60	0	10	90
B323618	8	3414	E	5	120	0	8	92
B323622	3	3954	W	5	270	0	15	85
V384034	0	3808	W	5	300	0	8	92
V36383	0	3905	N	5	340	0	8	92
V384015	5	3929	N	5	30	0	15	90
V384013	0	3901	N	5	330	3	7	90
V384027	0	3841	N	20	10	30	5	65
V384042	0	3933	N	45	350	40	5	55
V384012	5	3875	NW	20	300	0	10	90

V36382	0	3810	N	35	30	0	0	100
V36389	4	3817	W	5	270	0	5	95
V384039	0	3764	W	35	240	0	5	95
V384040	3	3710	N	20	360	5	5	90
V384024	0	3789	W	5	270	0	5	100
V384022	5	3880	S	5	170	8	10	85
V36381	0	3854	S	20	160	15	5	80
V384044	4	3913	W	20	240	35	5	60
V363810	7	3869	E	5	120	0	5	95
V363811	4	3910	NE	20	60	0	5	95
V363812	0	3965	NE	30	60	8	0	92
V384033	0	3853	E	20	130	0	0	100
V384028	0	3550	W	30	300	0	5	95

Releve	cows (100m)	plots(100m)	house (300m)	cropping(100m)	nearest path	cow droppings (10m)
V32361	10	1	1	1	125	10
B323651	8	0	1	1	125	7
B323652	0	0	1	0	125	12
B363812	5	1	1	1	300	4
B 49	8	1	0	0	300	2
B36384	0	1	0	0	1000	0
B363810	10	0	0	0	125	7
B323650	0	0	0	0	500	5
B36387	5	1	1	0	500	5
B323643	0	0	0	1	300	4
B323629	10	1	1	0	30	10
B323635	10	0	1	0	125	10
B323642	0	1	1	1	30	10
B32365	0	1	0	1	125	5
B323632	10	1	0	1	125	12
B32366	0	0	0	0	300	4
B323613	5	1	1	1	125	12
B323612	5	1	1	1	125	7
B323641	10	1	1	1	300	7
B323610	10	0	0	1	125	4
B323638	0	0	0	0	300	0
B383	0	0	0	0	500	3
B384	0	0	0	0	500	3
B36386	0	0	0	0	500	0
B36389	10	1	0	0	300	7
B36383	2	1	0	0	125	5
B36381	3	1	1	1	30	12
6	5	1	1	1	30	10
B323625	2	1	0	0	125	7
B323647	0	0	0	0	300	4
B32369	5	1	0	0	125	10
B323614	3	1	1	1	30	12
B323640	8	1	1	1	30	12
B323623	5	1	0	0	300	12
B32362	0	1	1	0	125	5
B323630	0	1	1	1	300	10
B323615	3	1	0	0	500	3
B323628	0	0	0	0	1000	0
B323648	0	0	0	0	1000	0
B323611	0	0	0	0	125	0
B382	0	0	0	1	125	0
B363815	0	0	0	0	500	0
B323621	0	0	0	0	1000	0
B36385	0	0	0	0	1000	0
B363818	5	1	1	0	125	5
B323620	2	1	1	1	125	8
B323634	0	1	0	1	300	4
B323636	10	0	0	0	300	15
B323618	5	0	0	0	300	8
B323622	0	0	0	0	500	3
V384034	0	0	0	0	500	0
V36383	3	0	0	0	300	0
V384015	5	0	0	0	125	5
V384013	0	0	0	0	300	0
V384027	0	0	0	0	500	0
V384042	0	0	0	0	1000	0
V384012	3	0	0	0	1000	5

V36382	0	0	0	0	500	0
V36389	0	0	0	0	500	4
V384039	0	0	0	0	500	0
V384040	0	0	1	0	300	3
V384024	0	1	0	0	500	0
V384022	0	0	0	0	500	5
V36381	0	0	0	0	500	0
V384044	0	1	0	0	500	4
V363810	0	1	0	0	1000	7
V363811	0	0	0	0	1000	4
V363812	0	0	0	0	1000	0
V384033	0	0	0	0	1000	0
V384028	0	0	0	0	300	0

Releve	Shannon	richness
V32361	2,188798	17
B323651	0,876789	15
B323652	0,949607	19
B363812	0,706751	12
B 49	0,686437	12
B36384	0,613846	8
B363810	1,007404	16
B323650	0,850259	12
B36387	0,774395	12
B323643	0,752987	13
B323629	0,902771	20
B323635	0,78018	17
B323642	1,018405	12
B32365	0,411681	8
B323632	0,456079	10
B32366	0,793474	7
B323613	0,860713	12
B323612	0,845034	11
B323641	0,588046	13
B323610	0,59168	9
B323638	1,066685	23
B383	0,765674	13
B384	0,991048	14
B36386	0,78738	15
B36389	0,708656	11
B36383	0,6386	7
B36381	1,001467	16
6	0,951636	16
B323625	0,471469	6
B323647	0,767956	8
B32369	0,98692	21
B323614	0,781403	14
B323640	0,559655	9
B323623	0,745801	8
B32362	1,032913	15
B323630	1,013841	14
B323615	1,009488	15
B323628	0,873755	15
B323648	0,999696	20
B323611	1,301234	26
B382	1,055235	21
B363815	1,175939	21
B323621	0,82976	12
B36385	1,009364	18
B363818	1,326544	29
B323620	0,955834	12
B323634	1,175047	23
B323636	0,973869	14
B323618	0,943818	19
B323622	0,884185	14
V384034	1,088416	21
V36383	1,067627	23
V384015	1,313846	29
V384013	1,234917	25
V384027	1,135074	20
V384042	0,866003	16
V384012	0,979182	18
V36382	1,113985	24
V36389	1,168888	23

V384039	1,137636	23
V384040	1,160936	26
V384024	1,169758	19
V384022	1,075445	16
V36381	1,192944	23
V384044	1,409229	27
V363810	1,045553	23
V363811	1,099891	22
V363812	1,04696	18
V384033	0,986907	24
V384028	1,100015	18