TECHNISCHE UNIVERSITÄT DRESDEN
Faculty of Forest, Geo and Hydro Sciences
Institute of International Forestry and Forest Products

SUTROFOR
European Erasmus Mundus MSc

MONITORING AND ANALYZING LAND USE/LAND COVER AND THEIR CHANGES USING REMOTE SENSING AND GIS IN THE ACHAMAYO AND SHULLCAS REGION, PERUVIAN ANDES

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HOMINEM ET AGRUM COLERE CUPIO

Outline

- Justification
- Main objective
- Specific objectives
- Methodology
- Study area
- Study area description
- Final considerations

Justification

- Crescent availability of remote sensing and GIS technologies[1]
  - Easier to monitor landscapes
- Change detection analysis by RS - insights on the **trends** and **drivers** and possible **future conversion:**
  - management plans, polices development, optimization of land uses[2]
- Population changes: growth (urban) and decrease (rural)[3]
  - One cause of land degradation in the Andes[4]
- The region is important for Peruvian agricultural sector[5]
  - also locally important being the sector that employs more in the region[3]
- Lack of knowledge on the forest cover on the region and its change

[1]Hall *et al*., 1995, Verburg *et al*., 2002b cited by Brandt and Townsend, 2006; Forrest *et al*., 2008; Müller and Zeller, 2002;
[2]Rogan and Chen, 2004; [3] IGP, 2005b; [4] Ayala Bluske, 1998 cited by Brandt and Townsend, 2006; [5] Latínez, 2010

Main Objective

To classify the land use/land cover in the study area, **to evaluate** the changes and **to identify** factors that determine land use allocation on the landscape, focusing on the activities related to trees

Specific Objectives

O1: To produce land use/cover maps

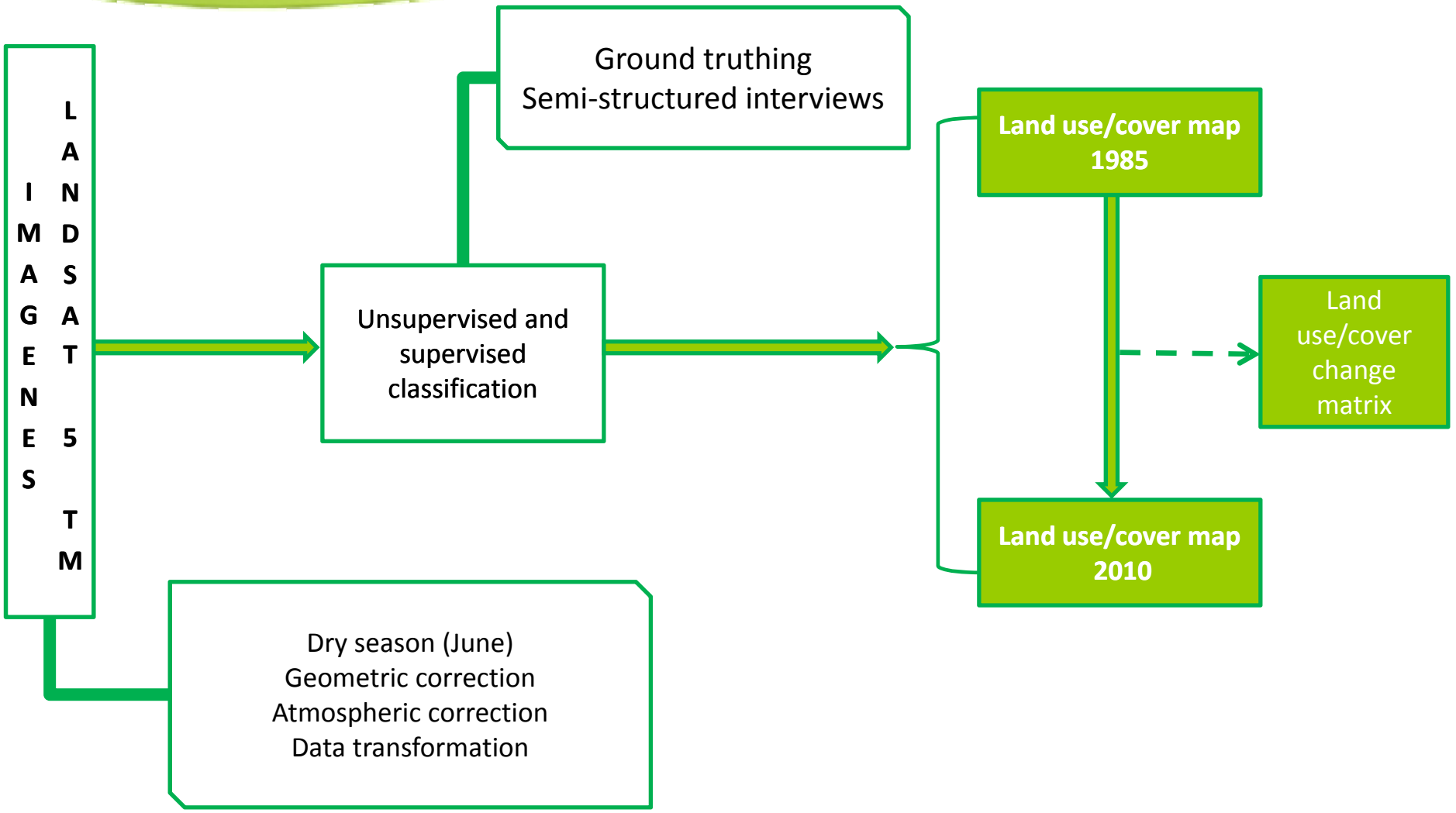
O2: To produce a land use/cover change matrix (1985-2010)

O3: To investigate patterns on the geographical localization of land uses

O4: To identify reasons for the land use/cover allocation in the landscape according to the population

O5: To verify information related to changes and land use/cover allocation with key informants

METHODOLOGY



METHODOLOGY

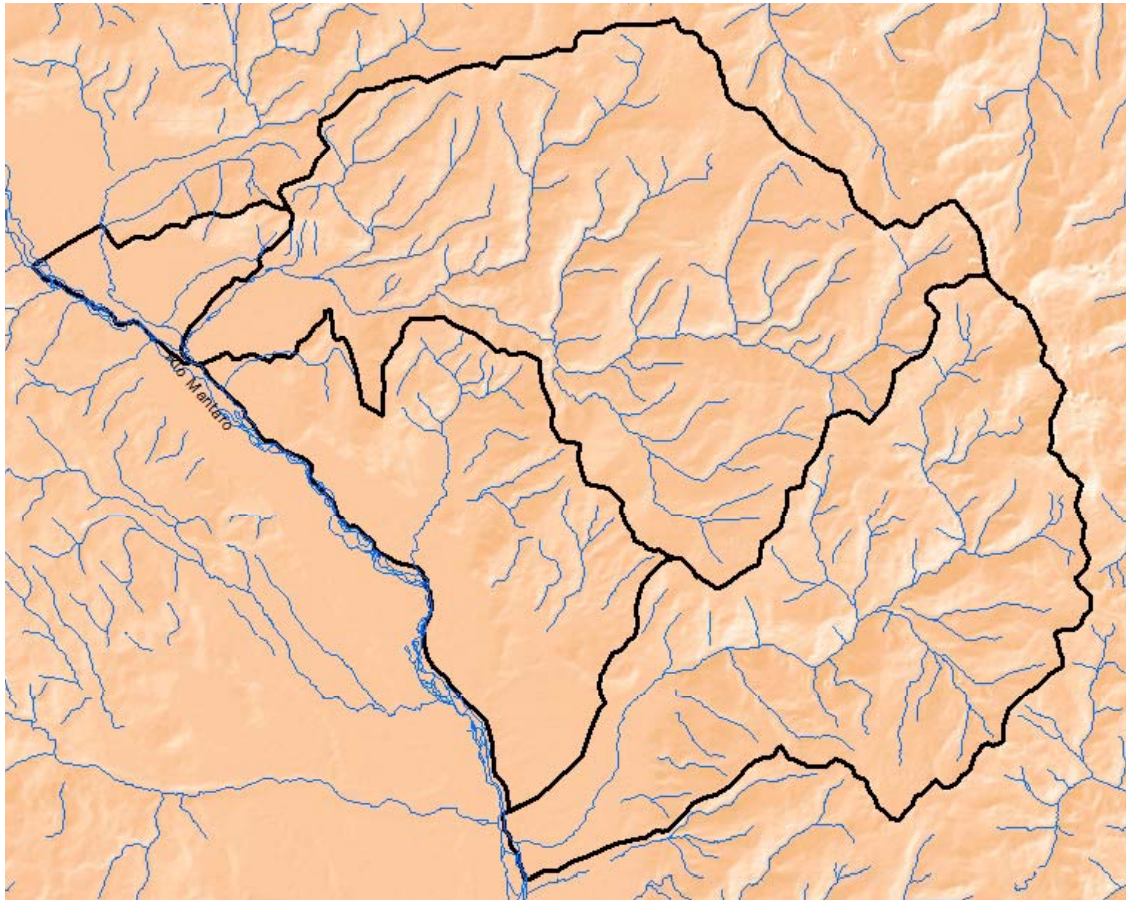
WEIGHT OF EVIDENCE METHOD

Altitude
Agro-ecological zones
Life zones
Slope
Soil type
Population density (by district)

GROUND TRUTHING

KEY INFORMANTS

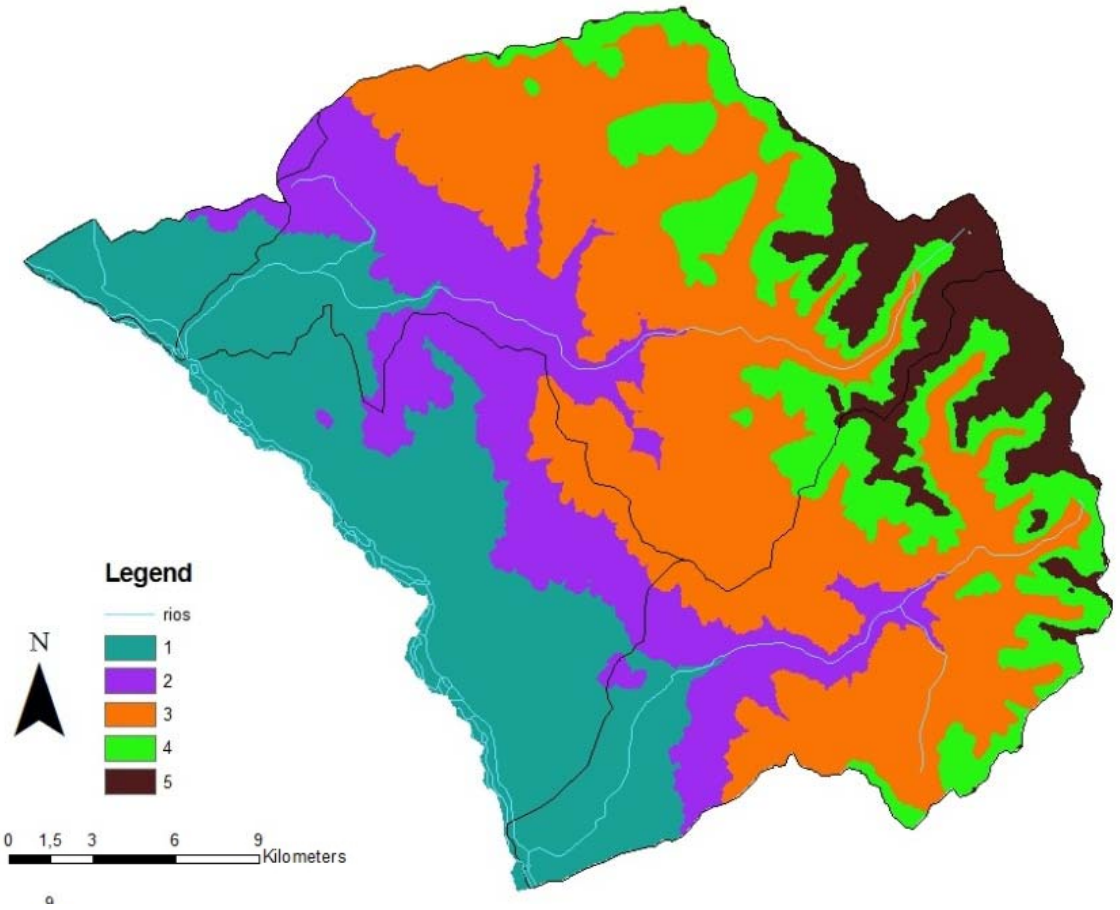
Study Area



Area	area (km^2)	%
Achamayo	308	44,3
Shullcas	223,5	32,2
Valley	137,5	19,8
Matahuasi	25,5	3,7
Total	694,5	100,0

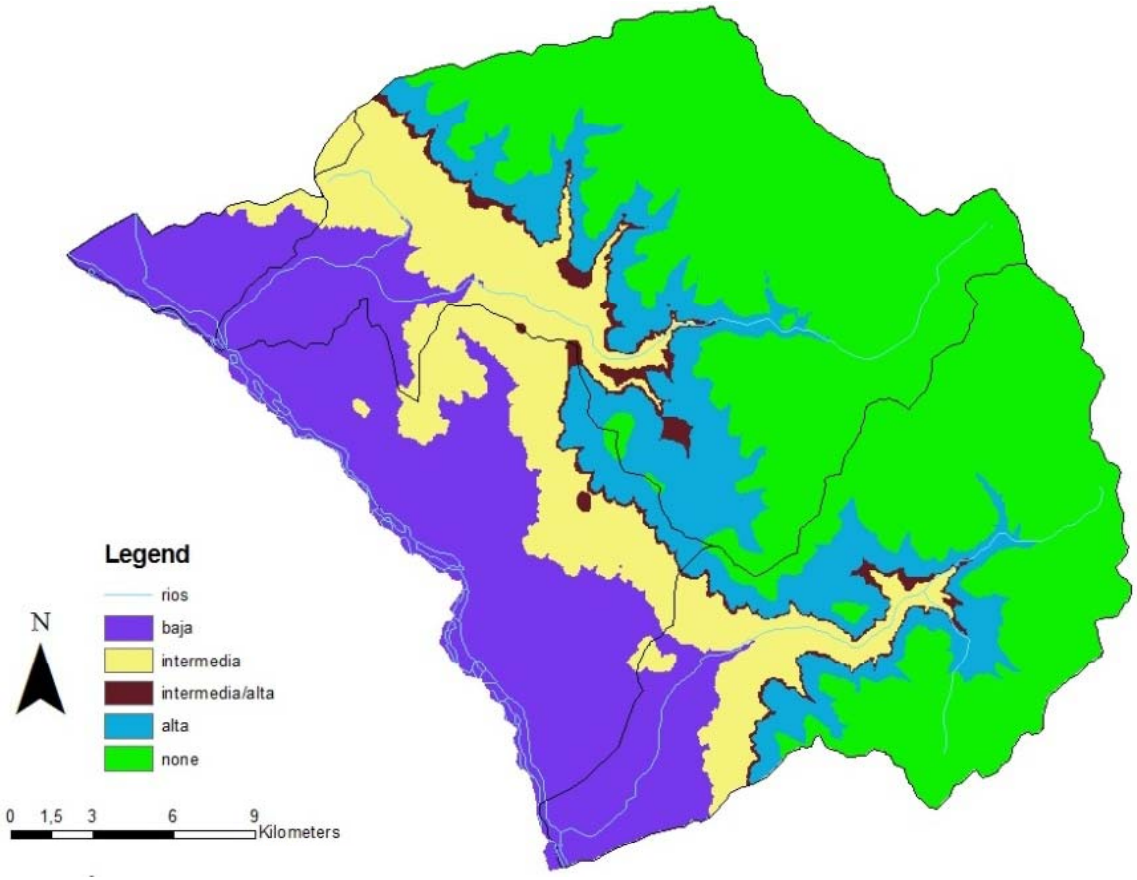
Study Area Description
Life Zones

- Based on the Holdridge classification
- Connects climate and ecology
- biotemperature, precipitation, potential evapotranspiration - Later: incorporation of altitudinal and latitudinal belts
- In the Andes, the climatic characteristics are related to the altitudinal values



Study Area Description
Agro-ecological Zones

- Based on the agricultural production
- Interaction of the of the life zones with labd use
- Criteria for determination: crops that can develop in each area
- Variation of climatic factor - also follows altitudinal ranges

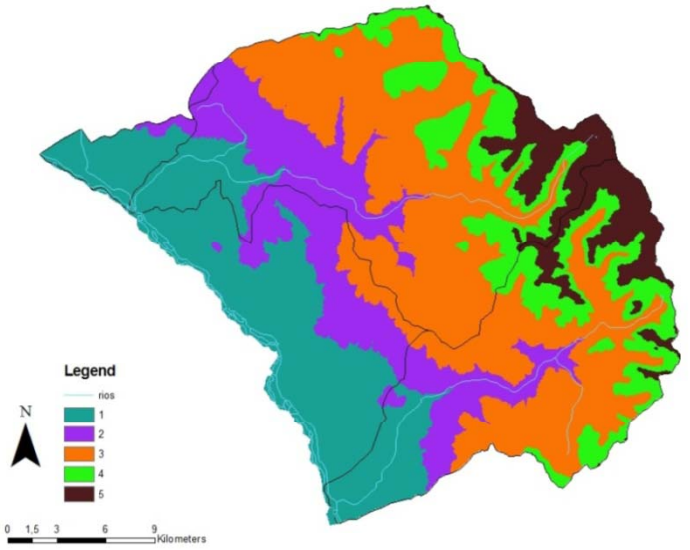


Study Area Description
Life and Agro-ecological Zones

Life zones	altitudinal range (m a.s.l.)	Agro-ecological zone	altitudinal range (m a.s.l.)
Nevados Tropicales (Cordillera) **Tropical snow peaks**	4650 or more	-	-
Tundra Pluvial Alpino Tropical **Tropical Alpine Pluvial Tundra**	4650 - 4500	-	-
Páramo Húmedo Subalpino Tropical **Tropical Subalpine Moist Paramo**	4500 - 4000	**Alta**	4250 - 3950
Bosque Húmedo Montano Tropical **Tropical Montane Moist Forest**	4000 -3500	**Intermedia**	4000 - 3500
Bosque Seco Montano Tropical **Tropical Montane Dry Forest**	3500 - 3000	**Baja**	3500 - 3000

NEVADOS TROPICALES (CORDILLERA)

- 4,650 m or more
- Cold temperatures and high humidity
- Under investigation due to the monitoring of the permanent snow cover at the peaks
- Liquens and micro-organisms

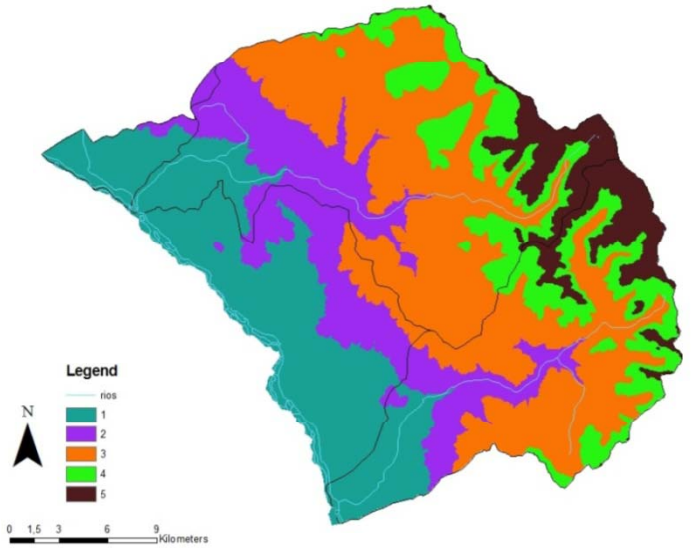


Area	area (km^2)	%
Achamayo	26,2	8,5
Shullcas	29,6	13,2
Valley	0	0,0
Matahuasi	0	0,0
Total	**55,8**	**8**

Mayer, 1981

Tundra Pluvial Alpino Tropical (Puna Alta)

- Between 4,500 and 4,650 m
- Cold and moist
- Presenting negative temperatures every night of the year - limitation for the development of vegetation
- *Bofedales*



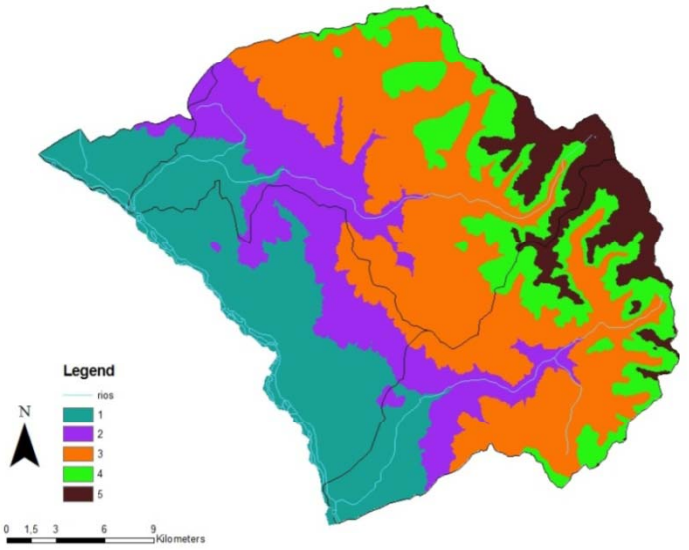
Area	area (km^2)	%
Achamayo	50,1	16,3
Shullcas	42,2	18,9
Valley	0	0,0
Matahuasi	0	0,0
Total	**92,3**	**13**

Mayer, 1981

Tundra Pluvial Alpino Tropical (Puna Alta)

Páramo Húmedo Subalpino Tropical (Puna Baja)

- 4,000 and 4,500 m
- Most representative zone (36%)
- Less humid (sub-humid) and warmer (semi-frigid)
- *Pajonales*
- Pastoralism: camelids, sheeps
- Agriculture in the lower part
- *Cobertizos*



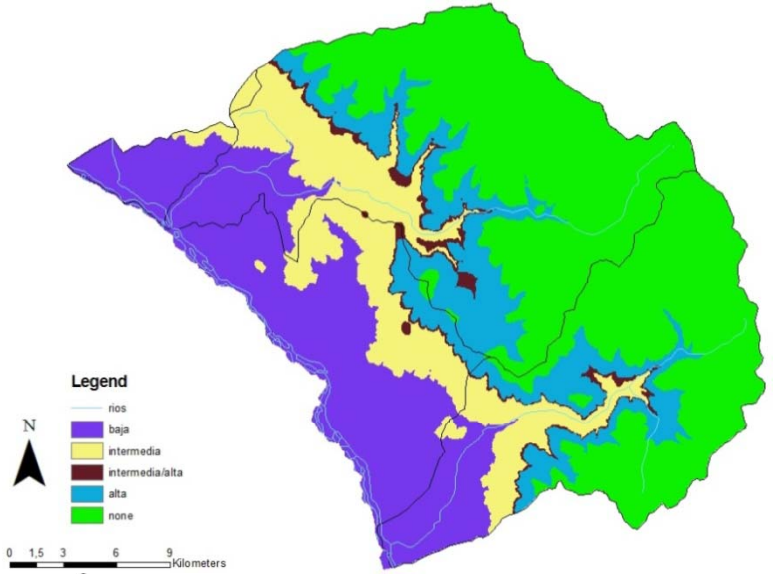
Area	area (km^2)	%
Achamayo	152,7	49,6
Shullcas	91,6	41,0
Valley	8,7	6,3
Matahuasi	0	0,0
Total	**253**	**36**

Mayer, 1981

Páramo Húmedo Subalpino Tropical (Puna Baja)

Páramo Húmedo Subalpino Tropical (Puna Baja) – Agro-Ecological Zone: Alta

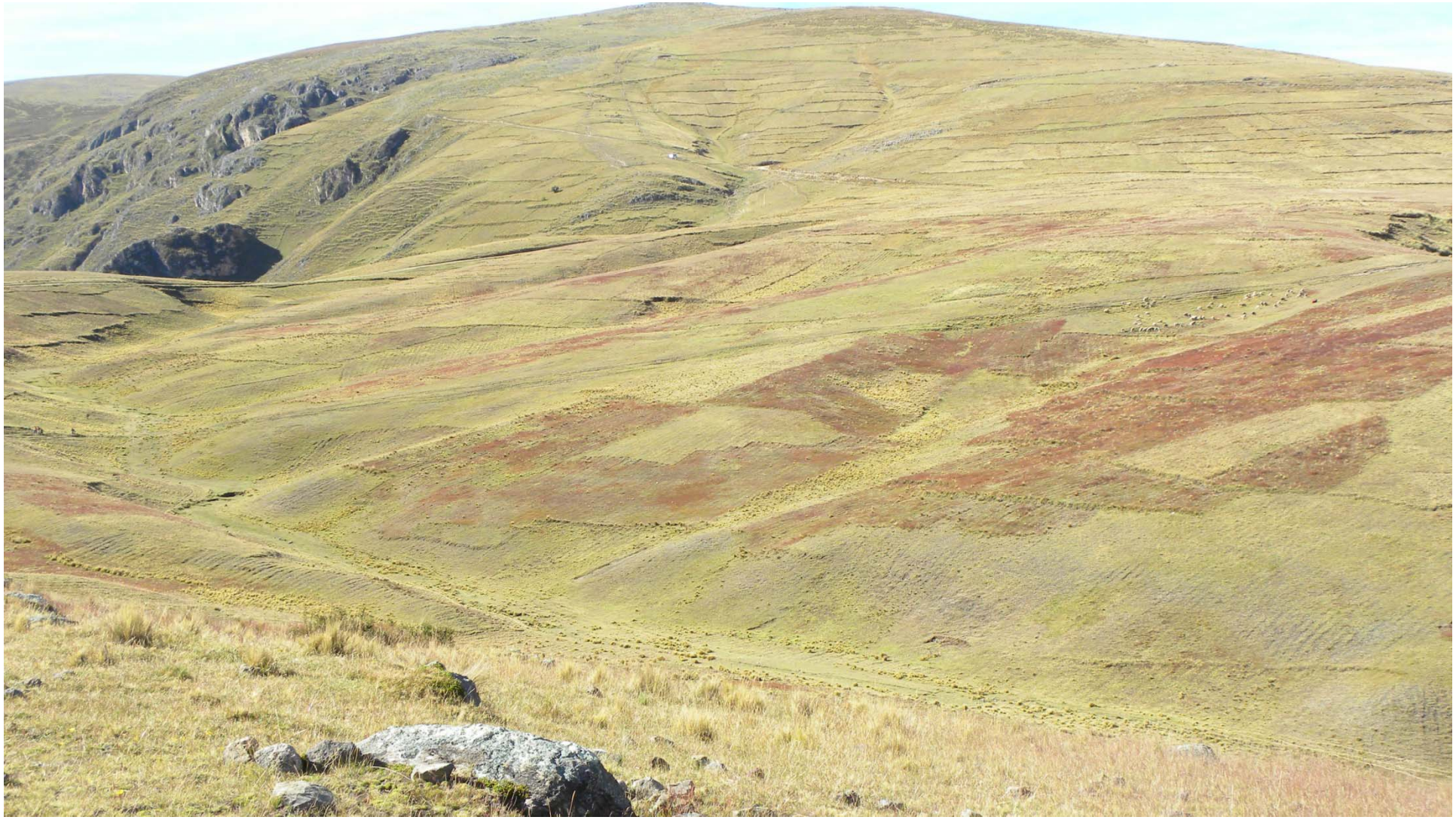
- 4250 – 3950 m a.s.l.
- Small fields on steep zones
- High frequency of frosts
- Some varieties of potato, barley and ulluco
- Fallow periods (3-9 years) - grazing
- Pastoralism is more representavive



Agro-ecological zones	Intermedia/ Alta		Alta	
Area	area (km²)	%	area (km²)	%
Achamayo	8,7	2,8	53,3	17,3
Shullcas	4,5	2,0	33,4	14,9
Valley	2,1	1,5	8,1	5,9
Matahuasi	0,0	0,0	0,0	0,0
Total	**15,3**	**2,2**	**94,8**	**13,6**

Mayer, 1981

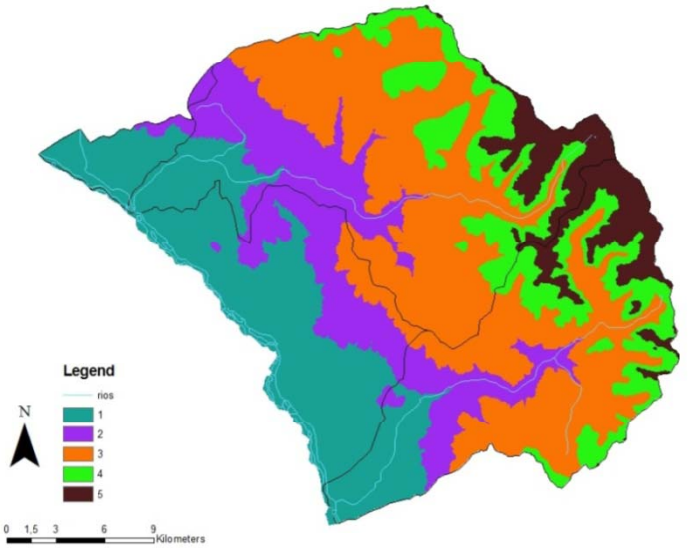
Páramo Húmedo Subalpino Tropical (Puna Baja) – Agro-Ecological Zone: Alta



Páramo Húmedo Subalpino Tropical (Puna Baja) – Agro-Ecological Zone: Alta

Bosque Húmedo Montano Tropical (Sierra Alta)

- 4,000 - 3,500 m
- Climate humid and cold
- Natural trees: *Polilepis*, *Buddleia, Alnus* - shrubs
- human activity in the area can be related to the current low presence of trees
- Pasture is the most frequent land cover in the zone with grasses (sheeps and bovinae)
- Land uses changes with altitude (pastoralism *vs.* agriculture)

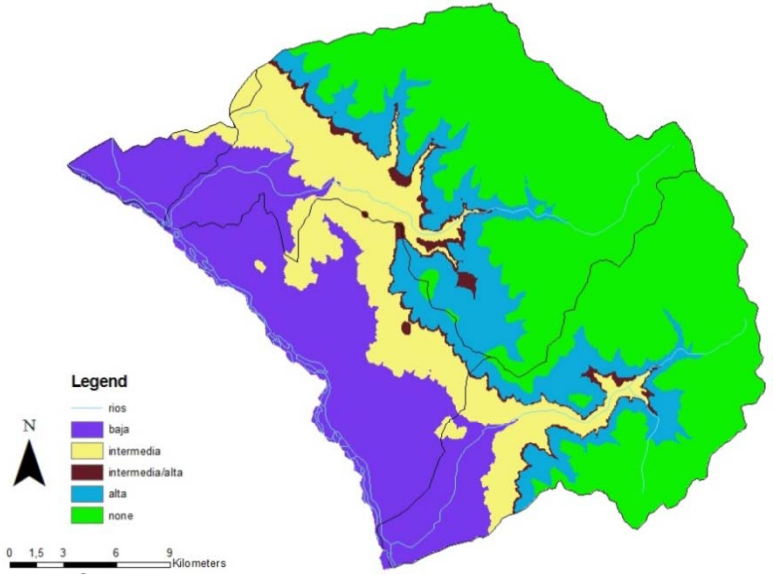


Area	area (km^2)	%
Achamayo	53,7	17,4
Shullcas	31,1	13,9
Valley	38,9	28,3
Matahuasi	2,6	10,2
Total	**126,3**	**18,1**

Mayer, 1981

Bosque Húmedo Montano Tropical (Sierra Alta) – Agro-Ecological Zone: *Intermedia*

- Greater cultivated area
- Shorter fallow periods (3-4 years)
- Papa, Mashua, oca, ulluco, barley, oat, wheat, broad bean
- two sub-zones: one with predominance of **tubers** and another with more grains
- self consumption and commercialization
- *Terrazas* are frequently found
- Trees: plantations, fences (eucalyptus, quinual)

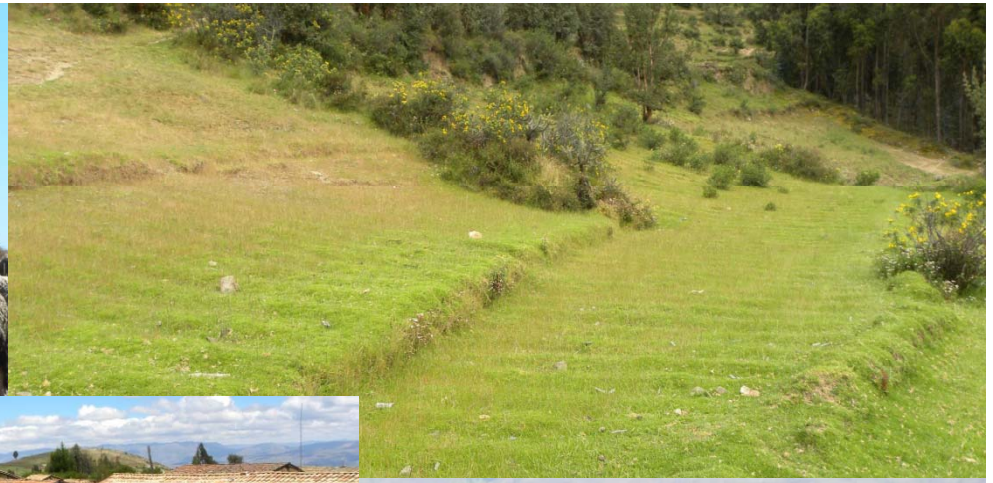


Agro-ecological zones	Intermedia		Intermedia/ Alta	
Area	area (km^2)	%	area (km^2)	%
Achamayo	44,9	14,6	8,7	2,8
Shullcas	26,7	11,9	4,5	2,0
Valley	36,9	26,8	2,1	1,5
Matahuasi	2,6	10,2	0,0	0,0
Total	**111,1**	**16,0**	**15,3**	**2,2**

Mayer, 1981

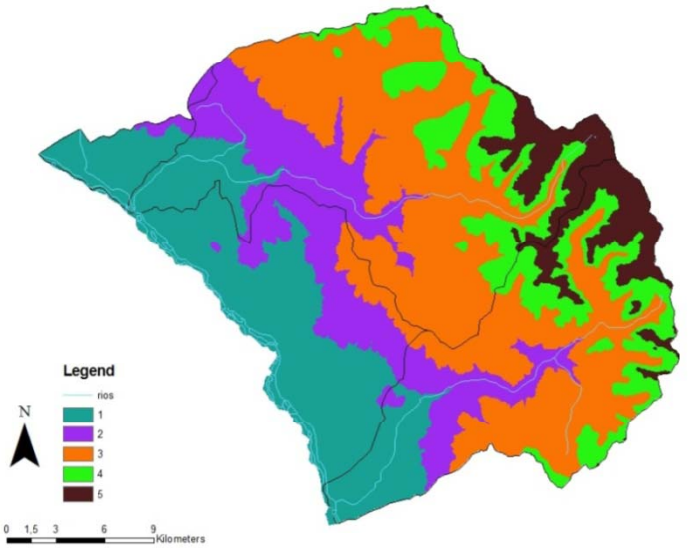
Bosque Húmedo Montano Tropical (Sierra Alta) – Agro-Ecological Zone: Intermedia

Bosque Húmedo Montano Tropical (Sierra Alta) – Agro-Ecological Zone: Intermedia



Bosque Seco Montano Tropical (Sierra)

- 3,000-3,500 m a.s.l.
- Mostly flat
- The climate is temperate and semi-arid
- Highest evapotranspiration rates
- *Eucalyptus* as fences and as plantations in steep slopes
- Highly populated: Huancayo and Concepción

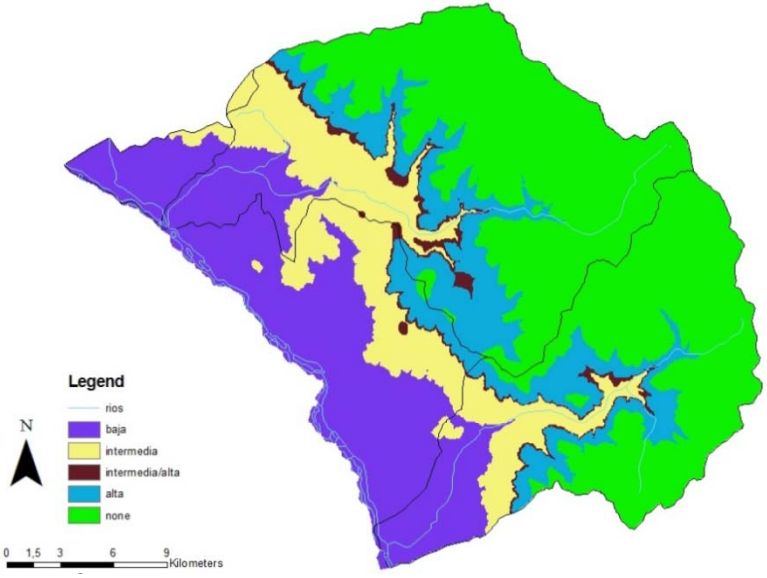


Area	area (km^2)	%
Achamayo	25,3	8,2
Shullcas	29	13,0
Valley	89,9	65,4
Matahuasi	22,9	89,8
Total	**167,1**	**24**

Mayer, 1981

Bosque Seco Montano Tropical (Sierra) – Agro-Ecological Zone: Baja

- Intensive agriculture
- High diversity of crops: climatic condition more favorable (globe artichoke, carrots, maize, potatoes, flowers)
- Sub-zones:
  - irrigation (present or not present)
  - destination of the production (commercial or for subsistence)
- Commercial zone: better quality, larger fields
- Use of chemicals (fertilizers and pesticides)
- Private and communal zone: leasing
- Trees (especially eucalyptus) as fences
  - protection
  - timber and firewood



Agro-ecological zones	Baja	
Area	area (km^2)	%
Achamayo	25,4	8,2
Shullcas	29,0	13,0
Valley	89,9	65,4
Matahuasi	22,9	89,8
Total	**167,2**	**24,0**

Bosque Seco Montano Tropical (Sierra) - – Agro-Ecological Zone: Baja

Bosque Seco Montano Tropical (Sierra) - – Agro-Ecological Zone: Baja

FINAL CONSIDERATIONS

- Lack of information concerning the land use/cover at a landscape level
- Urban expansion, loss of high quality agricultural areas
- Increase on the forest cover (1985-2010)
  - Bosquetes *vs.* large plantations – land tenure
- Marginal areas for forest: superficial and rocky soils, slopes
  - Trees development
- Altitude – limiting trees plantation
- Irrigation – affecting land use

FINAL CONSIDERATIONS

- Higher ground resolution imagery
- Selection of intermediate date for image analysis
  - Better understanding of changes: effects of climate change, seasonality, crop cycles
- Dynamism of changes: consider socio-economic scenario (population, political history, tenure)
- Monitoring plantations' development
- Investigation about most adapted clones and species
- Mapping of the irrigation channels


Thank you!
Obrigado
Questions?

LIFE ZONES

Life zones	1		2		3		4		5		**total**	
Area	area (km^2)	%	area (km^2)	%	area (km^2)	%	area (km^2)	%	area (km^2)	%	**area (km^2)**	**%**
Achamayo	25,3	8,2	53,7	17,4	152,7	49,6	50,1	16,3	26,2	8,5	**308**	**44,2**
Shullcas	29	13,0	31,1	13,9	91,6	41,0	42,2	18,9	29,6	13,2	**223,5**	**32,1**
Valley	89,9	65,4	38,9	28,3	8,7	6,3	0	0,0	0	0,0	**137,5**	**19,7**
Matahuasi	22,9	89,8	2,6	10,2	0	0,0	0	0,0	0	0,0	**25,5**	**3,7**
La Libertad	0	0,0	1,9	100,0	0	0,0	0	0,0	0	0,0	**1,9**	**0,3**
Total	**167,1**	**24**	**128,2**	**18,4**	**253**	**36**	**92,3**	**13**	**55,8**	**8**	**696,4**	**100,0**

AGRO-ECOLOGICAL ZONES

Agro-ecological zones	Baja		Intermedia		Intermedia/ Alta		Alta		none		**total**	
Area	area (km2)	%	area (km2)	%	area (km2)	%	area (km2)	%	area (km2)	%	**area (km2)**	**%**
Achamayo	25,4	8,2	44,9	14,6	8,7	2,8	53,3	17,3	175,7	57,0	**308,0**	**44,2**
Shullcas	29,0	13,0	26,7	11,9	4,5	2,0	33,4	14,9	129,9	58,1	**223,5**	**32,1**
Valley	89,9	65,4	36,9	26,8	2,1	1,5	8,1	5,9	0,5	0,4	**137,5**	**19,7**
Matahuasi	22,9	89,8	2,6	10,2	0,0	0,0	0,0	0,0	0,0	0,0	**25,5**	**3,7**
La Libertad	0,0	0,0	1,9	100,0	0,0	0,0	0,0	0,0	0,0	0,0	**1,9**	**0,3**
Total	**167,2**	**24,0**	**113,0**	**16,2**	**15,3**	**2,2**	**94,8**	**13,6**	**306,1**	**44,0**	**696,4**	**100,0**

SLOPE

Inclination level	plana a ligeramente inclinada		moderada a fuertemente inclinada		moderadamente empinada		empinada		extremamente empinada		**total**	
Area	area (km2)	%	area (km2)	%	area (km2)	%	area (km2)	%	area (km2)	%	**area (km2)**	**%**
Achamayo	66,4	21,6	121,8	39,5	78,2	25,4	41,5	13,5	0,1	0,03	**308**	**44,2**
Shullcas	57,7	25,8	63,2	28,3	59,5	26,6	43	19,2	0,1	0,04	**223,5**	**32,1**
Valley	64,1	79,2	33,1	6,3	29,8	8,2	10,5	6,3	0	0,00	**137,5**	**19,7**
Matahuasi	20,2	46,6	1,6	24,1	2,1	21,7	1,6	7,6	0	0,00	**25,5**	**3,7**
La Libertad	0,52	27,4	1,35	71,1	0,03	1,6	0	0,0	0	0,00	**1,9**	**0,3**
Total	**208,9**	**30,0**	**221,1**	**31,7**	**169,6**	**24,4**	**96,6**	**13,9**	**0,2**	**0,0**	**696,4**	**100,0**