



Effect of South American grazing camelids on soil fertility and vegetation at the Bolivian Andean grasslands



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ARTICLE INFO

Article history:

Received 1 December 2014
Received in revised form 12 February 2015
Accepted 3 April 2015
Available online xxx

Keywords:

Soil fertility
Plant communities
Highland grasslands
Camelid grazing
Biodiversity
Bolivian Andes

ABSTRACT

The high grasslands at Bolivian Andes provide a natural habitat for a high number of wild and domestic South American camelids such as vicuna (*Vicugna vicugna*) and alpaca (*Lama pacos*). Because of the importance of the camelid raising for the Andean inhabitants economy and the sustainable biodiversity, it is fundamental to determine the natural resources condition and their availability to camelids. The objectives of this research were to: (i) evaluate the soil fertility; (ii) characterize the plant communities and its relationship with the landscape; and (iii) analyze the effect of the camelid populations on soil properties, vegetation cover and plant species richness. Soil and vegetation samplings were carried out in eight areas with different vicuna densities. Results pointed out no effect of grazing camelids on soil properties, including soil fertility in all areas. The most plentiful plant community was *Pycnophyllum* sp. grassland, although it was highly disturbed due to domestic camelid grazing. The studied areas presented medium (30–50%) and high plant cover (>50%). The substitution of palatable by non palatable plant species in those zones with high alpaca concentration highlighted the negative domestic camelid effect on vegetation composition. No effect of vicuna grazing on vegetation was observed. However, some protection actions should be undertaken to prevent biodiversity decline by bringing resource over exploitation by domestic camelids in the Bolivian Andes.

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1. Introduction

The Apolobamba Integrated Management National Area is located in the Northern Bolivian Andes and provides a natural habitat for wild South American camelids such as vicuna (*Vicugna vicugna*) and domestic ones such as alpaca (*Lama pacos*) or llama (*Lama glama*). This one is scarcely present in some mixed flocks of alpaca and llama and little flocks of alpaca (SERNAP, 2006). Although no data on llama census are available the total llama is supposed fewer than 5% of the total alpaca (SERNAP, 2006). The presence of guanaco has not been described in Apolobamba. The main economical activity for Aymara and Quechua indigenous communities from Apolobamba is the domestic camelid raising. Vicuna has been a threatened species recognized by The World Conservation Union as vulnerable (IUCN, 1990) and classified as least concern in 2008 (Lischtenstein et al., 2008) pointing out the recovery of populations. Since their fleece is one of the finest fibres in the world, its exploitation is an example of

sustainable management of the biodiversity by indigenous communities (Agencia Española de Cooperación Internacional, 2004). Furthermore, Apolobamba area is one of the poorest zones in Latin American where Aymara and Quechua ethnic groups from three municipalities (Charazani, Curva and Pelechuco) present a human development index of 0.472 (Instituto Nacional de Estadística, 2005).

Ecosystems in the Puna or high altitude grasslands in the Andean region, are degraded as a consequence of anthropogenic activities such as the excessive grazing (Rocha and Sáez, 2003). The wild and domestic camelid populations have increased in the last decades with more than 140,000 animals in the Apolobamba area (130,000 alpacas and more than 10,000 vicunas) distributed in 1200 km² (SERNAP, 2006). The protection actions of vicuna have reduced noticeably the poaching increasing the populations mainly from 80s to the end of 90s (Agencia Española de Cooperación Internacional, 2004). Likewise, some owners of medium and big alpaca flocks have increased the number of animals coupled with a scarce genetic improvement (Agencia Española de Cooperación Internacional, 2004; SERNAP, 2006). The landscape has a communal use in Apolobamba (Rocha and Sáez,

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2003); therefore, wild and domestic camelids share natural resources such as soil and vegetation, as in others Andean grasslands (Borgnia et al., 2010).

The Andean ecosystem is a fragile environment with rigorous climatological conditions and low and variable quantity and quality of food for camelid grazing (Borgnia et al., 2010). Because of the importance of wild and domestic camelids population for the Apolobamba's inhabitants economy, it is fundamental to assess the condition of the natural resources in the region and their availability to camelids. Soil property determination can contribute to the understanding of the soil fertility and the grazing impact (Brady and Weil, 2008; Dorrough et al., 2006; Li et al., 2008). In addition, the high complexity and heterogeneity of the Andean habitats are assumed to be responsible for the variety in altitudinal distribution and compositional changes of the vegetation (Brunschön and Behling, 2010). There is a need for greater understanding of physico-chemical soil properties and the impact of management in the Andean region (Fonte et al., 2012). The botanical identification of the native species, the landscape description, the plant cover and the species richness provide significant information to understand the foraging ecology of the vicuna and the plant community evolution related to the camelid grazing impact (Borgnia et al., 2010; Seibert, 1993).

Limited information is available from previous studies conducted in the Northern Bolivian Andean regarding soil properties, vegetation and impact of camelid grazing (Beck et al., 2002; Seibert, 1993). In order contribute to one of the least well understood ecosystems around the world, the objectives of this research were to: (i) evaluate the soil fertility; (ii) characterize the plant communities and its relationship with the landscape; and (iii) analyze the effect of the camelids populations on soil

properties, vegetation cover and plant species richness in the Apolobamba area. The information obtained could improve the understanding of the proper management and the sustainable camelid exploitation in Andean grassland.

2. Materials and methods

2.1. Study area

Apolobamba is an Integrated Management National Area located in the Northwest of La Paz Bolivia, bordering with the Republic of Peru (Fig. 1). This area is composed by three ecological zones: Puna, valley and tropic with high, medium and low altitude range, respectively, covering an area of 4837 km² (SERNAP, 2014).

The research was carried out in the Puna of the Apolobamba area, the highest altitude ecological zone ranging from 4300 to 4900 m.a.s.l., with 1200 km² of extension (SERNAP, 2006). The study area is characterized by udic and frigid soil moisture and temperature regimes (USDA, 2014), with an annual average temperature of 4.5 °C and total precipitation of 505 mm concentrated in five months (November–March) (SERNAP, 2014). The zone exhibits a mountain landscape influenced by glacial processes and parent materials such as metamorphic pelite with slate, metalimonite and sandstone (SERNAP, 2006).

Considering the bioclimatic model proposed by Rivas-Martínez (2004) and the bioclimatic map developed by Navarro and Maldonado (2002), the area studied is classified as orotropical. The Puna of the Apolobamba area is included in the North Puna eco-region. Some authors assessed 148 species at the altoandine vegetation subeco-region in the Apolobamba area (Beck et al., 2002; García et al., 2002a).

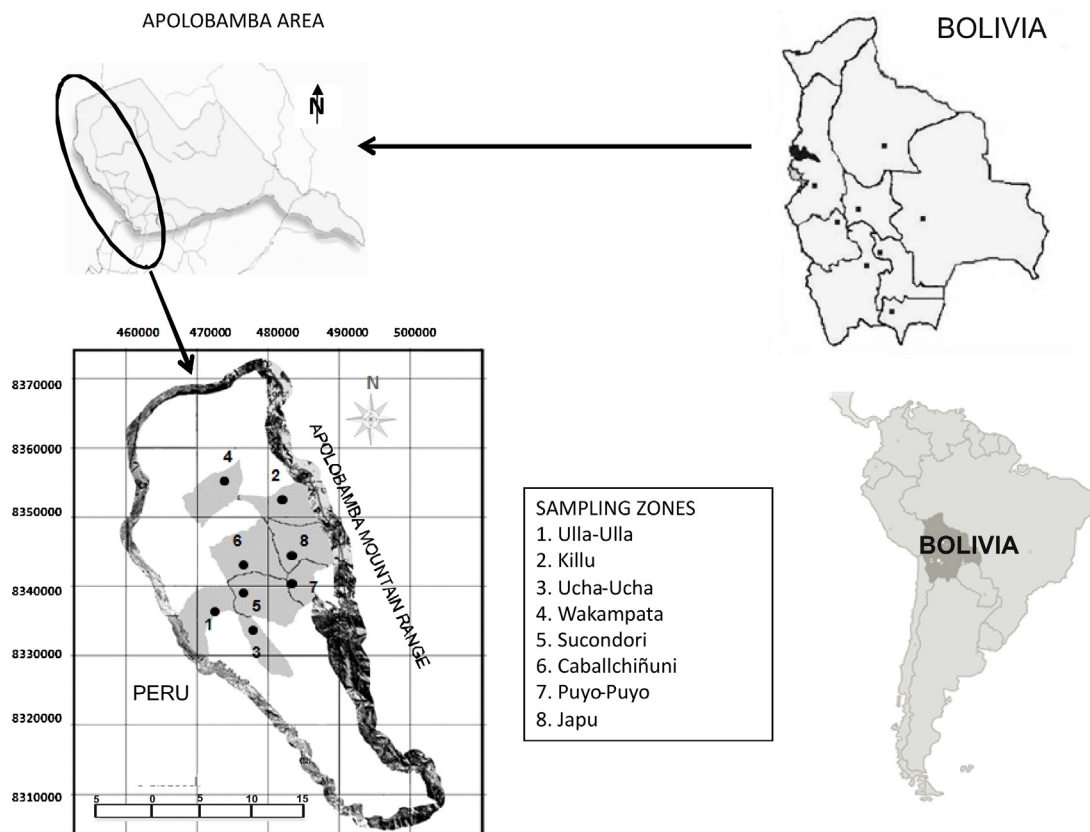


Fig. 1. Location of the Apolobamba area and sampling zones.

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