

# Relationship between soil chemical and physical properties and vegetation in the latest decade of alpine grasslands of southern Qinghai, China

Sachiko Idota<sup>A</sup>, Jiahua Yang<sup>B</sup>, Manabu Tobisa<sup>A</sup>, Xiaoqin Li<sup>C</sup>, Guomei Li<sup>D</sup>, Rende Song<sup>E</sup>, Haizhu Li<sup>F</sup>, Nobumi Hasegawa<sup>A</sup>, Masahiro Tasumi<sup>A</sup>, Naoyuki Yamamoto<sup>A</sup>, Aya Nishiwaki<sup>A</sup> and Yasuyuki Ishii<sup>A</sup>

<sup>A</sup> Faculty of University of Miyazaki, Miyazaki, Japan, 889-2192, [www.miyazaki-u.ac.jp](http://www.miyazaki-u.ac.jp)

<sup>B</sup> Interdisciplinary Graduate School of Agriculture and Engineering, University of Miyazaki, 889-2192, Japan

<sup>C</sup> Graduate School of Agriculture, University of Miyazaki, 889-2192, Japan

<sup>D</sup> Yushu Prairie Center, 815000 People's Republic of China

<sup>E</sup> Yushu Animal Husbandry and Veterinary Center, 815000 People's Republic of China

<sup>F</sup> Qinghai Academy of Animal Science and Veterinary Medicine, 810016 People's Republic of China

Contact email: [sidota@cc.miyazaki-u.ac.jp](mailto:sidota@cc.miyazaki-u.ac.jp)

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## Introduction

The Tibetan Plateau is one of the most important ecosystems in the world (Yang *et al.* 2009), particularly because of the global importance of its climate (Tian *et al.* 2008; Wang *et al.* 2008). Grassland ecosystems on the plateau are sensitive to global change, because the plateau is located in marginal land areas where the growth and distribution of plants depend heavily on local climatic conditions (Zhang *et al.* 1996). The alpine grassland of Qinghai Province in China has been traditionally used for extensive grazing by sheep and yak (*Bos grunniens*), but is now degraded from overgrazing.

This study investigated the relationship between soil chemical and physical properties and vegetation of alpine grasslands of southern Qinghai, China.

## Methods

The study was done in the Yushu National Ranch (Qinghai, China, 33°03'N, 96°50'E) from August 2004 to 2012; located in alpine grasslands (altitude 3970–4160 m). The climate is continental with a cool summer and cold winter (annual mean temperature 4.1 °C) and annual precipitation below 350 mm. Vegetation attributes (coverage, number of

plant species and herbage mass defoliated at the ground level) and soil chemical (pH, electric conductivity; EC, available phosphoric acid; Av-P, total nitrogen; TN, total carbon; TC, cation and anion concentration) and physical (hardness, moisture content, bulk density, elevation and angle of slope) properties were determined.

## Results and discussion

Soil pH was 6.5–8.2 and 6.6–9.2 in 2012 and 2004, respectively, and these values were similar to previous measurements (Yushu Tibetan-Autonomous State 1991). TN and Av-P ranged from 2-10 g/kg and 36-100 mg/kg, respectively among sites in 2012; Av-P values had increased from those in 2004. pH and C/N ratio increased with depth and EC, Av-P, TN and TC decreased (Fig. 1). There was a significantly positive correlation ( $P < 0.05$ ) between plant coverage and soil TN and cation concentrations, but no significant correlation of aboveground herbage mass with other soil chemical and physical properties (Table 1). It was concluded that soil chemical properties (pH, electric conductivity and Av-P, TN and TC concentrations) were not useful indicators of degradation, nor of general soil fertility of alpine grasslands under extensive yak-grazing in the latest decade.

**Table 1. Correlation coefficients of several soil properties (0-5 cm) and characteristics of vegetation in 2012.**

	HM <sup>†</sup>	Coverage	No. plant species	pH	EC	Av-P <sup>‡</sup>	TN <sup>§</sup>	TC <sup>¶</sup>	C/N	Anion	Cation	Hardness	Moisture content	Bulk density	Elevation	Angle of slope
HM	1															
Coverage	0.800**	1														
No. plant species	0.784**	0.666*	1													
pH	ns	ns	ns	1												
EC	ns	ns	ns	ns	1											
Av-P	ns	ns	ns	ns	ns	1										
TN	ns	0.718*	ns	ns	ns	ns	1									
TC	ns	ns	ns	ns	ns	ns	0.973***	1								
C/N	ns	ns	ns	ns	-0.880***	ns	ns	ns	1							
Anion	ns	ns	ns	ns	0.935***	ns	ns	ns	-0.817**	1						
Cation	ns	0.743*	ns	ns	ns	ns	ns	ns	ns	0.657*	1					
Hardness	ns	ns	ns	ns	ns	ns	ns	ns	0.707*	ns	ns	1				
Moisture content	ns	ns	ns	-0.634 <sup>†</sup>	ns	ns	0.789 <sup>**</sup>	0.762*	ns	ns	ns	ns	1			
Bulk density	ns	ns	ns	ns	ns	ns	-0.706*	ns	ns	ns	ns	ns	-0.781 <sup>**</sup>	1		
Elevation	ns	ns	ns	ns	ns	ns	ns	ns	ns	-0.754*	-0.805**	ns	ns	ns	1	
Angle of slope	ns	-0.686*	ns	ns	ns	ns	ns	ns	ns	ns	-0.755*	ns	ns	ns	0.860**	1

n = 10, \*, P < 0.05, \*\*, P < 0.01, \*\*\*, P < 0.001

<sup>†</sup>: Herbage mass defoliated at the ground level, <sup>‡</sup>: Available phosphoric acid, <sup>§</sup>: Total nitrogen, <sup>¶</sup>: Total carbon

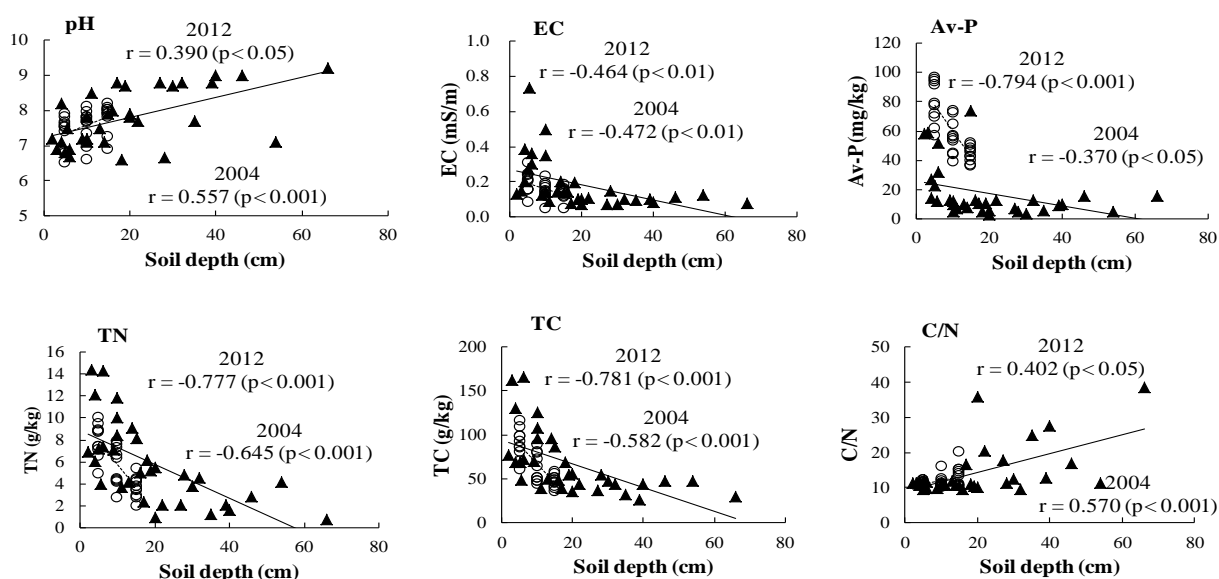


Figure 1. Relationship between soil depth and soil chemical properties in 2004 (▲, —) and 2012 (○, ---).

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