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# *Interactive comment on* "Predicting parameters of degradation succession processes of Tibetan *Kobresia* grasslands" *by* L. Li et al.

**L. Li et al.**

xuxingl@hotmail.com

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Dear referees, Thank you very much for constructive comments on our manuscript entitled as "Predicting parameters of degradation succession processes of Tibetan Kobresia grasslands" (se-2015-54). We have carefully revised our manuscript based on your comments. Please see our detailed responses point by point as follows:

1. The first and main concern is about"Introduction needs to be more specific about the related topic of the paper"

In the new version, we reorganized Introduction, more focusing on effects of livestock grazing on degradation in alpine grasslands, see lines 35-87: In the new version, we reorganized the introduction, please see lines 35-87: "Alpine grasslands are one of

the most important grassland types on earth, and they are distributed across the tundra zone of North Eurasia and North America. More than 48% of alpine grasslands are distributed on the Tibetan Plateau of China (Sun and Zheng, 1998; Wang et al., 1998; Harmsen and Grogan, 2008). Alpine grasslands represent one of the major natural types of pastures for pastoralists living in alpine regions, especially for those living on the Tibetan Plateau where livestock grazing is the most important human activity (Zhang et al., 2003a). Livestock mainly affects alpine grasslands through two ways. First, their grazing can affect the structure and composition of plant community, and the constitution of plant life forms and ecotypes in alpine grasslands (de la Paix et al., 2013; Zhao et al., 2013; Mekuria and Aynekulu, 2013). Second, their trampling can reduce infiltration rates, surface sealing, and physical crust formation (Cerda and Lavee, 1999; Angassa, 2014). With increased grazing, a part of alpine grasslands gradually degrade and become bare soil due to decreased vegetation protection (Zhang et al., 2003b; Zhang et al., 2003c; Wang et al., 2007a, b; Foggin, 2008). Consequently, this reduces the role of alpine grasslands in soil and water protection (Wen et al., 2010; Brandt et al., 2013; You et al., 2014). Such grazing-induced degradation of alpine grasslands has been observed in the early 2000s (Wang et al., 1997; Liu et al., 2008; Wang et al., 2009; Harris, 2010; Lin et al., 2013a, b), mainly because livestock number increased from approximately $0.8\times108$ in 1997 to $1.08\times108$ sheep unit in 2011 on the Tibetan Plateau (Yang, 2002; He et al., 2008; Sun, 2012). In the past decade, degradation in alpine grasslands has been getting more and more serious due to increasing grazing density. This has started to affect the living of pastoralists and the development of local economy. How to restore those degraded grasslands and maintain sustainable development of alpine grasslands is a big challenge. An important prerequisite for this is how to diagnose the degree to which alpine grasslands have degraded (Li et al., 2014). So far, numerous studies separately used plant community (Han et al., 2008; Lin et al., 2013a,b; Angassa, 2014; Giangiacomo, 2014) or environmental indexes (Lin et al., 2010, 2013a, b) as indicators to diagnose grassland degradation (Li et al., 2014; Wang et al., 2015). However, grassland degradation caused by grazing is



SED
7, C1182–C1186, 2015





a very complicated ecological process, including changes in both vegetation and soil. This emphasizes the importance of the plant-soil system for improving degradation of alpine grasslands. Among the plant-soil system, plants are the link of the atmosphere, biosphere, hydrosphere, and lithosphere (Brevik et al., 2015). The existence of plants can protect the soil surface against kinetic energy of drops, reduces runoff and increases infiltration (Groen and Wood, 2008). Therefore, the vegetation cover play a fundamental role in the soil development and soil erosion (Cerdà, 2002; Keesstra et al., 2014), and soil degradation (Ziadat and Taimeh, 2013), and also in the geomorphological (Nanko et al., 2015) and hydrological (Keesstra, 2007; Gabarrón-Galeote et al., 2013) behaviour of the Earth System and their interactions with the biota (Araújo et al., 2014; Bochet et al., 2015). At the same time, plants can shape soil microenvironments through living roots (Bardgett, 2002; Puente et al., 2004; Cerdà, 2002; Dai et al., 2013; Keesstra et al., 2014; Shang et al., 2014; Keesstra, 2014; Gabarrón-Galeote et al., 2013) and affects microbial function (Wang et al., 2015; Pereg and McMillan, 2015). In contrast to the vegetation, the soil system provides an important carrier for growth of plants and microorganisms. Almost all nutrient transformation processes operate by microorganisms in the soil. Therefore, the analysis on the soil-plant system must be approached from a multidisciplinary strategy (Brevik et al., 2015). To identify the degradation stages of the Tibetan Kobresia grasslands, we conducted a large field investigation in alpine grasslands across the Qinghai province. We collected a large number of indicators, including visible (e.g., species diversity, plant height, vegetation coverage, and plant biomass, plant functional groups) and invisible (e.g., root biomass, organic matter content, total nitrogen, and available nutrients in the soil). To reduce the parameters dimensionality (Lin et al., 2012), ordination and classification approaches were used for the multivariate analysis because it has been used to explore which factors contribute most to plant community change (Ali et al., 2014; Christopher, 2014). Therefore, our objectives of this study are to: (1) analyze the degree of degradation in grasslands through reducing the parameter dimensionality from a large number of visible and invisible parameters, and (2) develop a useful approach to diagnose and



SED
7, C1182–C1186, 2015





predict the extent of degradation of alpine grasslands for the sustainable development of alpine grasslands."

2. The second and main concern is about"Objectives should be addressed clearly following i), ii), iii)... In this new version, we mentioned our aims as follows: "Therefore, our objectives of this study are to: (1) analyze the degree of degradation in grasslands through reducing the parameter dimensionality from a large number of visible and invisible parameters, and (2) develop a useful approach to diagnose and predict the extent of degradation of alpine grasslands for the sustainable development of alpine grasslands." See lines 84-87.

3. The third and main concern is about"Study area. It is necessary to include a location map".

In this study, we investigated 96 plots in Haibei, Yushu and Guoluo in Qinghai province, and all of them belonged to the same vegetation type in 1992. The differences in community structure and species composition were due to different grazing intensities and management measures. Here we presented a map as Figure 1 to show these plots.

4. The forth and main concern is about"Conclusions. This section is missing and compulsory. Authors should be written it replying to the objectives. i), ii)....

As the referee suggested, we made conclusion as follows: (1) PFGs numerical features and root activity, together with certain physical properties of soil, could be used as indicators of the degree of degradation in alpine grasslands. The visible properties such as PFGs and the thickness of mattic epipedon were correlated with invisible properties such as root activities. Therefore, the degree of degradation of alpine grasslands can be predicted by development of mattic epipedon and changes in PFGs. (2) Alpine grasslands are very fragile to grazing and are easily degraded. Based on our study above, the degree of degradation in alpine grasslands can be well predicted using relatively few environmental factors. This approach can save time and easily help



SED

7, C1182–C1186, 2015

pastoralists to efficiently manage their grasslands. See lines 266-273.

Interactive comment on Solid Earth Discuss., 7, 2185, 2015.