Environmental Research 110 (2010) 302–307

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Rangeland degradation in North China: Perceptions of pastoralists ☆

Peter Ho [a,b], Hossein Azadi [c,*]

[a] Centre for Development Studies, Faculty of Spatial Sciences, University of Groningen, Groningen, The Netherlands
[b] College of Humanities and Development, China Agricultural University, Beijing, PR China
[c] International Institute for Asian Studies (IIAS), P.O. Box 9500, 2300 RA Leiden, The Netherlands

ARTICLE INFO

Article history:
Received 21 September 2009
Received in revised form
20 December 2009
Accepted 23 December 2009
Available online 27 January 2010

Keywords:
Rangeland trend
Rangeland degradation
Degradation severity
Pastoralists' perception
North China

ABSTRACT

Rangeland degradation, a worldwide problem, is serious in China, especially in the Northern provinces. To assess the pastoralists' perceptions toward rangeland trend and degradation, a survey was conducted in Ningxia, North China. Data were collected from a total of 284 pastoralists in six Ningxia counties. Findings showed that the majority of respondents believe the rangelands in Ningxia have been degraded, although there are some disparities among the counties that illustrate differing severity of degradation. Findings also clarified that the pastoralists have more knowledge about the "technical" and "supportive" aspects of conditions, while remaining less aware of "economic" and "management" factors of this issue. Yet, a high disparity was revealed between pastoralists' perceptions among the counties in this study. The correlation matrix showed that most of their perceptions do not act independently. Findings also showed that those pastoralists who believe that their rangeland trend is "improved" have broader management and social perceptions than those who believe their rangeland is "degraded". Finally, correlation analysis showed that the management and social perceptions have a negative correlation with degradation severity. Based on the findings, recommendations for possible interventions through extension/educational programs to diminish rangeland degradation are made. The programs are suggested to be presented in three packages including "management", "social", and "economic" issues in rangeland degradation.

1. Introduction

1.1. Rangeland trends[1] in North China

China is second in the world, just behind Australia, in rangeland area. There are 400 million hectares of rangelands, of which 313 million hectares can be grazed. China's rangelands are 41.7 percent of the land area (Ren et al., 2008) and, on a world scale, are 11.8 percent of the world's rangelands (Zhao et al., 2005). Over 50 percent of China's rangelands are located in the north, the area that is regarded as the traditional pastoral region. Northern China contains the world's third largest grassland, which supports the world's largest population of sheep and goats and the fourth largest concentration of cattle (Zhang and Yang, 1990). More than 36 percent (86.7 million hectares) of the grasslands of northern China are degraded, and the productivity of the range has decreased by 30–50 percent (Zhang, 1992). Although the productivity of the northern grasslands varies with geography and forage species, it is generally low. The area of natural grassland is gradually shrinking and the quality is degrading. Since 1949, an estimated 67 million hectares of high quality rangeland have been converted to the cultivation of grain, while only 8 million hectares of artificial grasslands, or about 2 percent of China's total rangelands, have been created. Consequently, the area of degraded rangeland is very large. Currently, 90 percent of the grassland is being degraded to varying extents (Zhang and Liang, 2001; Zhang, 2002, 2006). This has come about mostly due to overpopulation, overgrazing, improper reclamation, and adverse effects of droughts exacerbated by climate change (Li et al., 2008).

Rangeland degradation[2] and desertification occur mainly in the arid, poverty-stricken areas in the north of China, mainly in Xinjiang, Qinghai, Gansu, Inner Mongolia, and Ningxia. Ningxia, the area covered in this study, once belonged to a region called 'the land of grass' (Ho, 2003). Before much of the lush grassland

☆ Funding source: This study was partly funded by the EVD, Project Number AF06/CH/02.

* Corresponding author. Fax: +31 71 527 41 62.
E-mail addresses: p.p.s.ho@rug.nl (P. Ho), hos.azadi@gmail.com (H. Azadi).

[1] Rangeland trend (RT) is defined as the direction of change in a rangeland compared with its historic potential. Instead of evaluating the quantity, the quality of the rangeland can determine its trend so that, once determined, action can be taken to improve the rangeland (Holechek et al., 2001; Cox, 2005).

[2] Rangeland degradation (RD) is defined as a decrease in plant species diversity, plant height, vegetation cover, and plant productivity (Han et al., 2008).

0013-9351/$ - see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.envres.2009.12.007

was reclaimed by agricultural settlers, the whole landscape was one of rich grandeur. Reports from Sven Hedin's expeditions in the 1920s, and other reports from the 1930s, make it clear that the rangelands of Ningxia have deteriorated since that time (Hu et al., 1992). Today, Ningxia contains 3 million ha of grassland—about 45 percent of the total land surface. Of this, 2.3 million ha have been reported to be affected to some degree by desertification or soil erosion, while 2341 km^2 of rangeland has been classified as severely desertified (Han et al., 2008).

To date, the Chinese state has attempted to reduce degradation severity[3] of the rangelands mainly by reducing stocking rates and also through technical measures, such as aerial sowing (by plane), the construction of man-made ranges, and the sinking of wells (Ho, 2001). Nevertheless, due to the difficulties encountered in the implementation of rangeland policies, officials have gradually become aware that technical measures are only part of the solution and that rangeland management can only be successful if it includes pastoralists' perceptions and involves their participation.

1.2. Importance of pastoralists' perceptions

Pastoralists are one of the most researched yet least understood groups in the world. Despite decades of empirical research, many policy makers, government staff, nongovernmental (NGO) personnel, and the broader public do not fully appreciate the importance of pastoralists' expert perceptions (Hesse and Odhiambo, 2006; Azadi et al., 2007). The belief that pastoral livestock management is irrational and inherently destructive has a long history and has widely been accepted by scholars and officials in the international development community (Sandford, 1983). It originated with Herskovitz's (1926) hypothesis that pastoralists accumulate vast numbers of livestock mostly for reasons of social power and prestige. Hardin's (1968) notion, the tragedy of commons, has also been invoked to illustrate the irrational and destructive nature of pastoral management. Brown (1971) argued that pastoralists were irrational because they conducted dairy operations in environmental settings suited for beef production. Rooted in etic[4] view (Chambers, 1997), pastoralists often represent a minority vote, occupy vast areas of relatively invaluable land, and produce livestock products inefficiently.

As mentioned in Adano and Witsenburg (2006), until 1980, most governments, NGOs, and missionaries criticized pastoralists as irrational, ecologically destructive, and economically inefficient producers (Helland, 1980; Galaty, 1992; Homewood, 1995; Nunow, 2000). It is therefore not surprising that pastoralists and their interests were not very high on national policy agendas and according to the diffusion of innovations' theory (see Rogers and Shoemaker, 1971; Roling et al., 1976), they had to "accept" technologies recommended by etics to change their irrational thoughts and behaviors (Roling, 1979). Consequently, pastoralists were often restricted by their lack of knowledge, capacity, and resources from voicing their views and perceptions (Fratkin and Roth, 2004). At the same time, pastoralists underwent numerous setbacks. They were further marginalized by welfare, droughts, livestock diseases, and loss of wetlands to agriculture (Fratkin and Roth, 2004).

Since the 1980s, a new attitude toward pastoralists has emerged, marked by a conference entitled "The Future of Pastoral Peoples" (Dietz, 1987, p. 13, in Adano and Witsenburg, 2006) held in Nairobi in 1980. Some scholars, among them anthropologists and range ecologists, highlighted the importance of the emic[5] view, and influenced the acceptance of pastoralists as rational producers (Salzman, 1980; Galaty, 1981; Behnke et al., 1993; Scoones, 1995; Chambers, 1997; Fratkin, 1997; Goldsmith, 2003; Dalle et al., 2006; Hesse and Odhiambo, 2006; Sheehy et al., 2006). Many scientists who had worked with pastoralists and their ecosystems started opposing the idea of pastoralists' behavior as irrational and appreciating their knowledge and perceptions. They find many pastoral strategies perfectly rational, given the circumstances facing the herders in question (Helland, 1980; Sandford, 1983; Swift and Maliki, 1984; Ellis and Swift, 1988; Goldstein et al., 1990; Mace, 1991; Azadi et al., 2009b). These studies cast doubt on the premise that pastoralism leads inevitably to the destruction of rangelands. The studies contain many cases around the world where pastoral practices are not irrational and worth appreciation. The fact that the pastoralists with the most experience have the greatest stake in rangelands makes it important to study their perceptions. Taking a "bottom-up" approach (Sheehy et al., 2006) into account, this study aims to understand the pastoralists' perceptions toward rangeland degradation in Ningxia. More specifically, the study seeks to answer (1) How do pastoralists categorize the current trends of their pasture? (2) How severe is rangelands degradation perceived by pastoralists? (3) How diverse is their perceptions among the counties? (4) Are there any associations between the perceptions, (5) Are there any differences among the perceptions toward rangeland trends? (6) Are there any relationships between different perceptions and degradation severity?

2. Materials and methods

2.1. Study site

This article is based on fieldwork conducted in six counties (Xiamaguan, Xinzhuangji, Chengjiao, Ma'erzhuang, Guanting, and Chengyang) in Ningxia. Ningxia Hui Autonomous Region is one of the smallest provinces in China. It is situated in the central Asian steppe and desert region with a continental, temperate climate increasing in aridity from the south (sub-humid) to the north (arid). Ningxia is stretched from the Helen Mountains in the north to the Liupan Mountains on the Loess Plateau in the south. The area is enclosed by the Tengger and Mu'us deserts (northwest and northeast, respectively). Ningxia Hui Autonomous Region is bordered by Shaanxi Province to the east, Inner Mongolia to the north and west, and by Gansu Province to the south (Fig. 1). The province is dominated by the fertile plain of the Yellow River in the north, where since the Qin and Han dynasties irrigation channels have been built on a 400-km stretch of the river. Ningxia includes a total land surface area of 66 400 km^2 and contains 4.24 million people—of which 1.37 million (32 percent) belong to the Islamic Hui minority. Instead of being administered as a province, Ningxia was carved out as an Autonomous Region for the Hui in 1958 (Mitchell et al., 1998; Ho, 2001).

2.2. Study sample

In total, 284 pastoralists (240 men and 44 women) were selected for interview through a cluster random sampling method where Xiamaguan contributed 49 (17.3 percent), Xinzhuangji 47 (16.5 percent), Chengjiao 50 (17.6 percent), Ma'erzhuang 48 (16.9 percent), Guanting 47 (16.5 percent), and Chengyang 47 (16.5 percent) of the pastoralists.

2.3. Data collection

Using a questionnaire, this research was conducted through a survey. The questionnaire was approved through face validity and the reliability was confirmed by estimating Cronbach's alpha for the perceptions factors (α=0.74).

2.4. Data analysis

The data were analyzed using SPSS software (version 16). To understand the pastoralists' perceptions toward RT, RD, and DS, 64 questions were chosen in

[3] Degradation severity (DS) is commonly defined as the rate of rangeland degradation (Holechek et al., 2001).

[4] Outsiders' views (e.g., policy makers and scientists).

[5] Insiders' views (e.g., farmers and pastoralists).

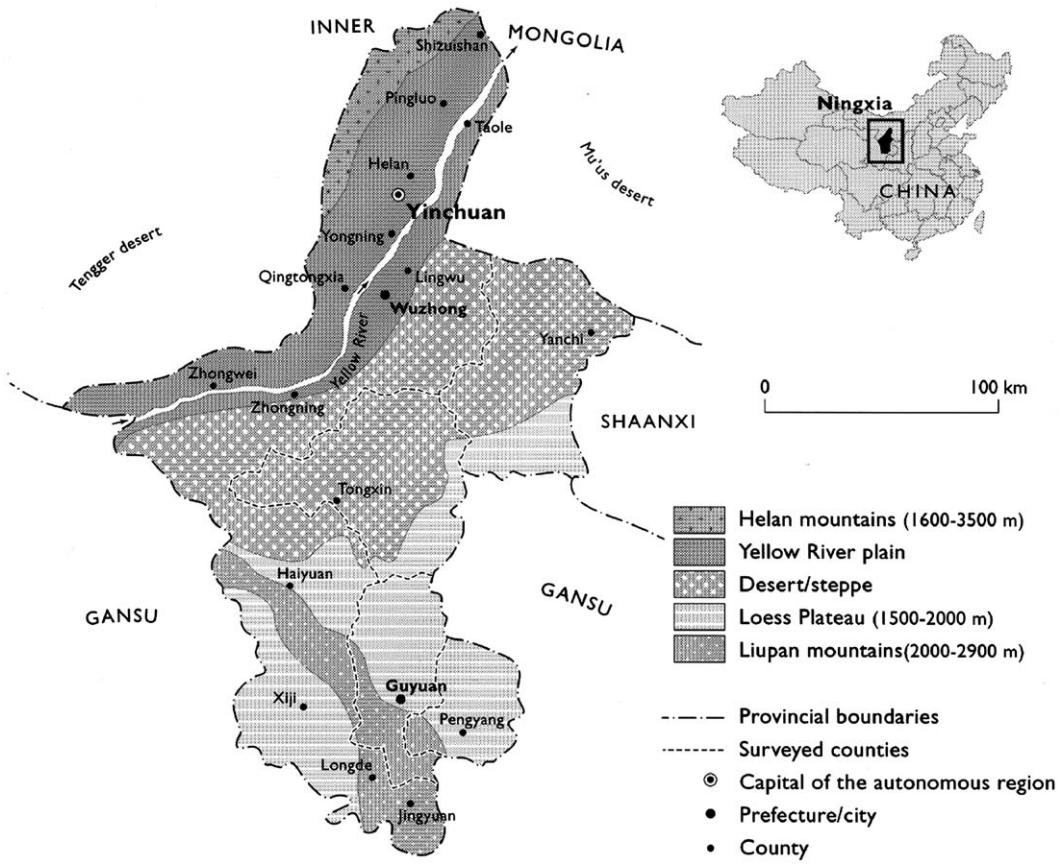

Fig. 1. Geo-ecology of Ningxia.

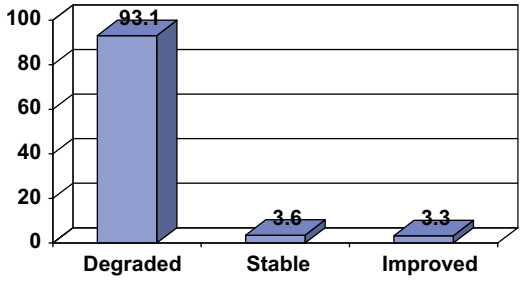

Fig. 2. Three different levels of RT in Ningxia.

Table 1
Means comparison of DS among the counties (ANOVA) $F=6.59$; Sig.=0.00.

County	RT mean[a]
Xiamaguan	−5.00a
Xinzhuangji	−4.89a
Chengjiao	−3.40b
Ma'erzhuang	−4.89a
Guanting	−4.36a
Chengyang	−3.40b

[a] Common letters show non-significant mean (estimated by LSD, $P \leq 0.05$).

eight different categories[6]: Technical (11 questions), Policy (12 questions), Management (8 questions), Activities (8 questions), Economic (7 questions), Social (6 questions), Supportive (6 questions), and Institutional (6 questions), to be asked of each respondent. Each correct answer scored 5 points while the incorrect received 0. Three levels (degraded, stable, and improved[7]) of RT, according to Cox (2005) and Holechek et al. (2001) were considered as the current status of the pasture compared to 5 years earlier. Consequently, DS was also estimated based on the levels of RT, that is, degraded (−5), stable (0), and improved (+5).

[6] The categories are defined based on the pastoralists' knowledge, respectively, about "technical", "state policies", "management", "conservational", "economic", "social empathy", "socio-political supports", and "institutional arrangements" issues in rangeland management.

[7] If the proportions of primary forage species increase relative to non-forage species, the trend is considered upward (improved) while the reverse is a downward (declined) trend. If there are no changes, the trend is stable (Cox, 2005). Generally, a change in ecological condition score of 5 percent or more is considered to indicate an upward or downward trend. Otherwise range condition is considered to be stable (Holechek et al., 2001).

3. Results and discussion

3.1. Rangeland trend

According to Cox (2005) and Azadi et al. (2009b), pastoralists, by experience, can usually estimate the trend of their pastures through the years. They generally know what species and in what quantity decreased or increased in total. In our study, pastoralists considered three different levels for RT (Fig. 2).

As shown in Fig. 2, the majority of respondents (264 pastoralists, 93.1 percent) believe that their rangelands (compared to 5 years earlier) have "degraded" while only 11 (3.6 percent) and 9 (3.3 percent) of the questioned pastoralists evaluated the RT at the "stable" and "improved" levels, respectively.

This finding was formerly confirmed by Ho (1998, 1999, 2000) as well as newly supported by Sheehy et al. (2006), Han et al. (2008), and Squires et al. (2009). They have explained that the RD is thought to have begun in China by the late 1960s and since then

the degraded has increased by 15 percent each decade. Han et al. (2008) also discuss that in the last 10 years the degraded area has risen from 55 to over 90 percent. They all believe that most of this degradation is happening in northern China.

3.2. Degradation severity in different counties

Considering six different counties of the study, an ANOVA was run to find the mean difference of the DS in the counties. As shown in Table 1, all the counties hold minus mean quantities, indicating they are all facing degradation. Nevertheless, there are some disparities among the counties that show different severities of degradation; Xiamaguan suffered from the highest severity of degradation (-5.00) while Chengjiao and Chengyang faced the least (-3.40).

This finding can generally be confirmed by Liu et al. (2003), who found that the overall severity of land degradation in northern China has worsened during the last two decades while, more specifically, Ho (1998) proved that degradation severity is most serious in the northern and central parts of Ningxia, where damage to communication lines and agricultural land by drifting sand has been reported.

3.3. Perceptions

As described in Table 2, the pastoralists have different perceptions toward the RD. While Technical and Supportive perceptions have the highest means (16.10 and 15.00, respectively), Economic and Management perceptions have the lowest (7.63 and 7.65, respectively). This shows that the respondents have more knowledge of technical and supportive factors, but are less aware of the economic and management factors involved in RD.

The standard deviation shows that the economic knowledge of the pastoralists has the least variations (± 5.2) among all the perceptions, while their knowledge regarding institutional and supportive factors is most varied (± 8.68 and ± 8.5, respectively). This finding is different from Katjiua and Ward's (2007) fieldwork regarding the importance of studying the Namibian pastoralists' perceptions and observations in a survey. They concluded that among seven different perceptions studied, technical perceptions were most consistent. In another study, Kassahun et al. (2008) concluded that, based on the pastoralists' perceptions, a lack of suitable management, policy, and institutions are influencing RD in eastern Ethiopia.

Table 2
Descriptive analysis of the pastoralists' perceptions about RD.

Perceptions	Mean	Mode	Std. deviation	Range	Min.	Max.
Technical	16.10	17	± 6.5	30	5	35
Policy	14.56	10	± 7.1	40	0	40
Management	7.65	5	± 6.8	25	0	25
Activities	9.17	5	± 6.5	25	0	25
Economic	7.63	10	± 5.2	25	0	25
Social	10.91	10	± 6.3	30	0	30
Supportive	15.00	15	± 8.5	30	0	30
Institutional	8.68	5	± 6.4	30	0	30

3.4. Perceptions in different counties

Table 3 breaks down pastoralists' perceptions by the different counties of the study. It demonstrates a high diversity of pastoralists' perceptions among the counties. Pastoralists in Ma'erzhuang have the highest (19.92) technical perceptions among all the counties while Chengyang's pastoralists have the lowest (9.66). RD Policy awareness is greatest (17.50) in Guanting whereas it is least (11.46) appreciated in Ma'erzhuang. Yet, Chengyang's pastoralists have the lowest (3.92) perceptions of RD management while Xinzhuangji's shows the highest comprehension (12.34). As for activities, Chengjiao pastoralists show the most (11.90) knowledge and Guanting the least (4.57). Economic perceptions are most (9.48) comprehended by Xinzhuangji's pastoralists while least (5.20) understood by the pastoralists in Xiamaguan. Regarding social perceptions, Chengyang's pastoralists have the least (5.89) knowledge and Xinzhuangji's have the most (14.13). Finally, supportive perceptions received the highest (19.28) score in Xiamaguan, with Chengyang the lowest (9.53). All the above-mentioned differences in perception are significantly confirmed by ANOVA and LSD tests, while institutional perceptions showed no significant differences among the counties.

3.5. Associations among perceptions

To understand the perceptions' associations, a correlation matrix is shown in Table 4. As the table shows, most of the perceptions have significant (mostly at $P \leq 0.01$) correlation with one another. It means they normally do not act independently. There are, however, some perceptions that operate independently: Technical with Policy and Social; Policy with Economic, Social, and Institutional; Activities and Economic with Social. It is important to note that the only perception that correlates with all the others is Management. It means that the Management perception of the pastoralists can fluctuate with all the others. In other words, developing greater comprehension of management may improve all of the pastoralists' perceptions and vice versa. We will clarify this in the next sections.

Table 3
Means comparison of perceptions among the counties (ANOVA).

Perceptions	Mean[a]						*F*	Sig
	Xiamaguan	Xinzhuangji	Chengjiao	Ma'erzhuang	Guanting	Chengyang		
Technical	15.58a	17.28ab	13.66ac	19.92b	11.50ac	9.66c	6.31	0.00
Policy	15.07a	16.93a	12.27ab	11.46b	17.50ab	15.07ab	2.28	0.05
Management	11.12a	12.34a	6.70b	5.60bc	5.65bc	3.92c	13.73	0.00
Activities	10.31a	10.10a	11.90a	10.31a	4.57b	7.30c	8.89	0.00
Economic	5.20a	9.46b	7.80b	7.87b	7.60b	7.94b	3.36	0.00
Social	13.40a	14.13a	10.20b	8.43b	12.93a	5.89c	13.61	0.00
Supportive	19.28a	18.55ac	14.59bd	15.93bc	11.52de	9.53e	10.90	0.00
Institutional	8.22a	9.88a	9.48a	8.29a	8.15a	7.97a	0.69	0.62

[a] Common letters in each row show non-significant mean (estimated by LSD, $P \leq 0.05$).

Table 4
Pearson correlations among the perceptions.

Perceptions	Technical	Policy	Management	Activities	Economic	Social	Supportive	Institutional
Technical	1.00							
Policy	0.06	1.00						
Management	0.43**	0.22**	1.00					
Activities	0.29**	0.27**	0.25**	1.00				
Economic	0.27**	0.08	0.13*	0.21**	1.00			
Social	0.09	−0.05	0.21**	−0.02	0.05	1.00		
Supportive	0.28**	0.23**	0.30**	0.36**	0.17**	0.17**	1.00	
Institutional	0.27**	0.14	0.17**	0.15*	0.06	0.15**	0.23**	1.00

* $P \leq 0.05$.
** $P \leq 0.01$.

Table 5
Means comparison of perceptions among the RT levels (ANOVA).

Perceptions	Mean[a]			*F*	Sig.
	Degraded	Stable	Improved		
Technical	10.00a	16.32a	18.00a	1.03	0.35
Policy	21.50a	14.25a	14.52a	0.93	0.39
Management	2.77a	7.00ab	7.80b	2.38	0.02
Activities	6.66a	9.06a	10.55a	0.85	0.42
Economic	7.22a	7.55a	11.11a	1.99	0.13
Social	7.22a	8.88ab	11.16b	2.17	0.04
Supportive	10.00a	15.50a	15.17a	1.62	0.19
Institutional	8.42a	12.00a	7.22a	1.72	0.18

[a] Common letters in each row show non-significant mean (estimated by LSD, $P \leq 0.05$).

Table 6
Spearman correlation between perceptions and DS.

Perceptions	*R*
Technical	−0.04
Policy	0.07
Management	−0.13*
Activities	−0.02
Economic	0.07
Social	−0.12*
Supportive	−0.09
Institutional	0.02

* $P \leq 0.05$.

3.6. Perceptions and rangeland trends

To understand the pastoralists' perceptions about RT, an ANOVA was run. As shown in Table 5, for most of the perceptions those pastoralists who assess their RT at the "improved" and "stable" levels have broader knowledge than those who evaluate their RT at the "degraded" level. However, among all the perceptions, only Management and Social are significant in this regard. This means that those who believe their RT has improved have significantly greater Management and Social perceptions compared with those who believed their RT had degraded (7.80 vs. 2.77 and 11.16 vs. 7.22, respectively).

3.7. Perceptions and degradation severity

The role of Management and Social perceptions in RT can be better understood by the correlation analysis between DS and perceptions. As shown in Table 6, most of the perceptions have negative correlation with DS. However, there are again two perceptions that have significant correlations with DS: Management and Social ($R = -0.13$ and -0.12, respectively). It means that the broader the pastoralists' Management and Social perceptions, the less we can expect degradation.

According to Liu et al. (2003), Azadi et al. (2009a), unlike natural factors, socio-economic factors have not been commonly used in assessing degradation severity. They believe the assessment of degradation trends would be more realistic if socio-economic factors (such as pastoralists' perceptions) are taken into account. The findings of Tables 5 and 6 show the importance of management and social perceptions on declining DS, which can be supported by Zhang's study (2006) in Shanxi province, where he emphasized the lack of suitable management strategies and social supports to halt declining RD and highlighted the importance of suitable policies in this regard.

4. Conclusion

Rangeland degradation in China is recognized as a severe and on-going problem. Such a multi-dimensional concept involves value judgments by different stakeholders, more importantly by the pastoralists who are the main users and hold the biggest stake in rangelands. This study was conducted to determine the pastoralists' perceptions toward rangeland trends and degradation in the six counties of Ningxia, north China.

This study revealed that, in the pastoralists' view, despite various rates of severity, all the counties are suffering rangeland degradation. Since the economic and management issues were identified as the weakest perceptions in the pastoralists' view, it is important to train – e.g., through extension/educational programs – the pastoralists and improve their economic and management knowledge. Furthermore, since those pastoralists who categorize their RT "improved", have stronger management and social perceptions than the others; these perceptions could be the main focus of extension/educational programs. It is important to note that management is the only perception which is positively correlated with all the others. Accordingly, development of the level management knowledge among the pastoralists should be the first priority of such programs, followed by social and economic perceptions. The extension/educational programs can therefore be presented in three packages called "management", "social", and "economic" issues in rangeland degradation. The details of such packages should further be elaborated by conducting some qualitative researches in next studies.

Acknowledgments

The authors wish to thank Arjen Schutten and Thierry van Helden of the EVD (the Economic Extension Agency) of the Dutch Ministry of Economic Affairs for their support through the ProLAND project. In addition, we would also like to express our

gratitude to Dr. Irene Bain of the Ford Foundation for her generous advice and strong help in revitalizing our research on Chinese grasslands. Last but not least, we also thank Prof. Gao Guiying of Ningxia University, China.

References

Adano, W.R., Witsenburg, K., 2006. Once nomads settle. Assessing the process, motives, and welfare changes of settlements on Mount Marsabit. In: Bates, D.G., Lozny, L.R., Fratkin, E., Roth, E.A. (Eds.), As Pastoralists Settle. Studies in Human Ecology and Adaptation, pp. 105–136.

Azadi, H., Shahvali, M., Berg, J., Faghih, N., 2007. Sustainable rangeland management using a multi-fuzzy model: how to deal with heterogeneous experts' knowledge. Journal of Environmental Management 83 (2), 236–249.

Azadi, H., van den Berg, J., Ho, P., Hosseininia, G., 2009a. Sustainability in rangeland systems: introduction of fuzzy multi objective decision making. Current World Environment 4 (1), 19–32.

Azadi, H., Berg, J., Shahvali, M., Hosseininia, G., 2009b. Sustainable rangeland management using fuzzy logic: a case study in southwest Iran. Agriculture, Ecosystems and Environment 131 (3&4), 193–200.

Behnke, R.H., Scoones, I., Kerven, C., 1993. Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas. Overseas Development Institute, London.

Brown, L.H., 1971. The biology of pastoral man as a factor in conservation. Biological Conservation 3 (2), 93–100.

Chambers, R., 1997. Whose Reality Counts? Intermediate Technology Publications. Bath Press, London.

Cox, N.D., 2005. Rangeland trend: quality vs. quantity. Rangelands 27 (8), 12–14.

Dalle, G., Maass, B.L., Isselstein, J., 2006. Encroachment of woody plants and its impact on pastoral livestock production in the Borana lowlands, southern Oromia, Ethiopia. African Journal of Ecology 44, 237–246.

Ellis, J.E., Swift, D.M., 1988. Stability of African pastoral ecosystems: alternate paradigms and implications for development. Journal of Range Management 41 (6), 450–459.

Fratkin, E., 1997. Pastoralism: governance and development issues. Annual Review of Anthropology 26, 235–261.

Fratkin, E.M., Roth, E.A., 2004. As Pastoralists Settle. Kluwer Academic Publishers Group.

Goldsmith, P., 2003. Perception of Pastoralism in Kenya. Available at 〈http://www.reconcile-ea.org/publ/pastoralist_perception.pdf〉.

Galaty, J.G., 1981. Introduction: nomadic pastoralists and social change processes and perspectives. In: Galaty, J.G., Salzman, P.C. (Eds.), Change and Development in Nomadic and Pastoral Societies. International Studies in Sociological and Social Anthology, Series 133. Brill, Leiden, pp. 4–26.

Galaty, J.G., 1992. The land is yours: Social and economic factors in the privatization, sub-division and sale of Maasai ranches. Nomadic Peoples 30, 26–40.

Goldstein, M.C., Beall, C.M., Cincotta, R.P., 1990. Traditional conservation on Tibet's northern plateau. National Geographic Research 6 (2), 139–156.

Han, J.G., Zhang, Y.J., Wang, C.J., Bai, W.M., Wang, Y.R., Han, G.D., Li, L.H., 2008. Rangeland degradation and restoration management in China. The Rangeland Journal 30, 233–239.

Hardin, G., 1968. The tragedy of the commons. Science 162, 1243–1248.

Helland, J., 1980. An outline of group ranching in pastoral Maasai areas of Kenya. Working Document No. 17, International Livestock Centre for Africa (ILCA), Kenya.

Herskovitz, M.J., 1926. The cattle complex in East Africa. American Anthropologist 28, 230–272.

Hesse, C., Odhiambo, M.O., 2006. Strengthening pastoralists' voice in shaping policies for sustainable poverty reduction in ASAL counties of East Africa. In: Conference on Pastoralism and Poverty Reduction in East Africa: A Policy Research Conference, June 2006, Nairobi, Kenya, pp. 27–28.

Ho, P., 1998. Ownership and control in Chinese rangeland management since Mao: a case-study of the free-rider problem in pastoral areas in Ningxia, P.R. China. In: Vermeer, E.B., Chong-Woerkom, W.L., Pieke, F. (Eds.), Between State and Private Interest: Chinese Rural Collectives and Voluntary Peasant Organisations. M.E. Sharpe, New York, pp. 196–235.

Ho, P., 1999. Rangeland policy, pastoralism and poverty in China's Northwest: Ningixa Province in the Twentieth Century. Ph.D. Dissertation, Leiden University.

Ho, P., 2000. China's rangelands under stress: a comparative study of pasture commons in the Ningxia Hui autonomous region. Development and Change 31, 385–412.

Ho, P., 2001. Rangeland degradation in north China revisited? A preliminary statistical analysis to validate non-equilibrium range ecology. The Journal of Development Studies 37 (3), 99–133.

Ho, P., 2003. The wasteland auction policy in northwest China: solving rural poverty and environmental degradation? Journal of Peasant Studies 30 (3/4), 121–159.

Holechek, J., Galf, D., Navarro, J., 2001. What's the trend? Rangelands 23 (3), 10–13.

Homewood, K., 1995. Development, demarcation and ecological outcomes of Maasailand. Africa 65 (3), 331–350.

Hu, S.T.P., Hannaway, D.B., Youngberg, H.W., 1992. Forage Resources of China.. Pudoc, Wageningen.

Kassahun, A., Snymanb, H.A., Smit, G.N., 2008. Impact of rangeland degradation on the pastoral production systems, livelihoods and perceptions of the Somali pastoralists in Eastern Ethiopia. Journal of Arid Environments 72, 1265–1281.

Katjiua, M., Ward, D., 2007. Pastoralists' perceptions and realities of vegetation change and browse consumption in the northern Kalahari, Namibia. Journal of Arid Environment 69, 716–730.

Li, X.L., Yuan, Q.H., Wan, L.Q., He, F., 2008. Perspectives on livestock production systems in China. The Rangeland Journal 30, 211–220.

Liu, Y., Gao, J., Yang, Y., 2003. A holistic approach towards assessment of severity of land degradation along the Great Wall in northern Shaanxi province, China. Environmental Monitoring and Assessment 82, 187–202.

Mace, R., 1991. Conservation biology: overgrazing overstated. Nature 349, 280–281.

Mitchell, D.J., Fullen, M.A., Trueman, I.C., Fearnehough, W., 1998. Sustainability of reclaimed desertified land in Ningxia, China. Journal of Arid Environments 39, 239–251.

Nunow, A.A., 2000. Pastoralists and markets: livestock commercialisation and food security in north-eastern Kenya. Ph.D. Dissertation, University of Amsterdam.

Ren, J.Z., Hu, Z.Z., Zhao, J., Zhang, D.G., Hou, F.J., Lin, H.L., Mu, X.D., 2008. A grassland classification system and its application in China. The Rangeland Journal 30, 199–209.

Rogers, E.M., Shoemaker, F., 1971. Communication of Innovations: A Cross-Cultural Approach 2nd ed. Free Press, New York.

Roling, N.G., 1979. The logic of extension. Indian Journal of Extension Education XV (3,4), 1–8.

Roling, N.G., Ascroft, J., Chege, F.W., 1976. The diffusion of innovation and the issue of equity in rural development. Communication Research 3, 155–170.

Salzman, P.C., 1980. Introduction: Processes of sedentarisation as adaptation and response. In: Salzman, P. (Ed.), When Nomads Settle: Processes of Sedentarisation as Adaptation and Response. Praeger Publishers, New York, pp. 1–19.

Sandford, S., 1983. Organization and Management of Water Supplies in Tropical Africa. ILCA Research Report (Addis Ababa, Ethiopia), pp. 20–31.

Scoones, I., 1995. Living with Uncertainty: New Directions in Pastoral Development in Africa. International Institute for Environment and Development, IT Publications, London.

Sheehy, D.P., Thorpe, J., Kirychuk, B., 2006. Rangeland, livestock and herders revisited in the northern pastoral region of China. In: USDA Forest Service Proceedings, vol. RMRS-P-39, pp. 62–82.

Squires, V., Lu, X., Wang, T., Lu, Q., Yang, Y., 2009. Rangeland Degradation and Recovery in China's Pastoral Lands. Oxford University Press.

Swift, J., Maliki, M., 1984. A Cooperative Development Experiment Among Nomadic Herders in Niger. Overseas Development Institute (Paper 18c).

Zhang, J.-T., 2002. A study on relations of vegetation, climate and soils in Shanxi Province, China. Plant Ecology 162 (1), 23–31.

Zhang, J.-T., 2006. Grassland degradation and our strategies: a case from Shanxi province China. Rangelands 28 (1), 37–43.

Zhang, J.-T., Liang, J.H., 2001. The analysis of economic loss of ecological destruction in Shanxi North China. China Softscience 16 (5), 89–94.

Zhang, X., 1992. Northern China. In: Zhang, X. (Ed.), Committee on Scholarly. Grasslands and Grassland Sciences in Northern China.. National Academy Press, Washington, DC, pp. 39–54.

Zhang, X., Yang, D., 1990. Radiative dryness index and potential productivity of vegetation in China. Journal of Environmental Sciences 2 (4), 95–109.

Zhao, H.L., Zhao, X.Y., Zhou, R.L., Zhan, T.H., Drake, S., 2005. Desertification processes due to heavy grazing in sandy grassland, Inner Mongolia. Journal of Arid Environments 62, 309–319.