防治荒漠化理论与实践（第三卷）

PRINCIPLES AND PRACTICES OF DESERTIFICATION CONTROL(VOLUME-3)

PROCEEDINGS OF THE THIRD INTERNATIONAL SPECIALTY CONFERENCE ON SCIENCE AND TECHNOLOGY FOR DESERTIFICATION CONTROL

第三届国际防治荒漠化科学技术大会论文集

胡跃高 朱立君 ◎ 主编

气象出版社
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前　言

2014年6月17日是第20个世界防治荒漠化与干旱日。这一天，来自俄罗斯、乌兹别克斯坦、伊朗、尼日利亚及中国的专家在北京召开了“第三届国际防治荒漠化科学技术大会”。本次会议设置了“认识荒漠化”、“区域性荒漠化问题”、“牧区与荒漠化问题”和“防治荒漠化”四项议题，集中进行研究讨论，目的在于从防治荒漠化角度来认识荒漠化，然后指导行动。与会专家共同倡议联合上海合作组织国家，共建中亚防治荒漠化工程，并形成建议报告。

会后，遴选主要参会论文汇编出版文集，收录了会议开幕式致辞、贺词5篇，研究论文16篇，摘要2篇，并附《联合上海合作组织国家，共建中亚防治荒漠化工程——第三届国际防治荒漠化科学技术大会建议报告》全文。

在如何正确认识荒漠化这个问题上，草原生态学家刘书润教授指出，应该把人为造成的荒漠化问题与自然荒漠化和沙漠化分开讨论，人为造成的荒漠化，才是真正的荒漠化，其本质是多样性的丧失，思想的单纯化、极端化和反传统文化。宋怀龙高工的研究结果表明，古地中海区域干涸形成的巨大盐漠是撒哈拉大沙漠、阿拉伯半岛大沙漠形成的基础和直接原因。盐漠及盐碱（混合）尘暴在地球演变史、地球生态环境变化、世界荒漠主要格局和生命诞生演变与进化，特别是人科动物形成等方面曾起到过重要作用。

对于区域性荒漠化问题的研究涵盖范围较广。俄罗斯科学院通讯院士A. K. Tulokhonov等人在遥感和GIS技术支持下基于归一化植被指数（NDVI）对蒙古国干旱气候带部分盟进行研究表明，近年来该地区植被退化区域在扩张，指出应加强对放牧的科学管理。俄罗斯科学院西伯利亚分院贝加尔资源管理研究所Endon. Zh. Garmaev所长等人分析认为，未来贝加尔湖流域河水径流量将发生显著变化，无法预测到21世纪中叶该湖支流的变化情况。蒙古国科学院地理所Enkh. Amgalan所长报告指出，蒙古国生态系统不稳定性增强，气候异常，暴风雨和干旱成灾，对矿业、农牧业造成不利影响，加剧了荒漠化和草场退化，并产生了一系列社会问题。刘清和王卷乐副研究员采用最新的1990年和2010年两期土地利用覆被数据，运用栅格运算对蒙古国荒漠化区域的时空分布和1990—2010年间荒漠化发展特征进行分析，结果表明，近二十年来蒙古国城镇面积增长迅速，土地变化剧烈，大量的森林和草地遭到破坏，裸地面积大量增加，同时部分裸地退化为沙地。俄罗斯科学院西伯利亚分院贝加尔资源管理研究所D. A. Darbalaeva的研究表明，蒙古国鄂尔浑（Orkhon）盟人民生活水平较其他盟为高，但因荒漠化加重，其生态经济形势不容乐观。宋乃平教授研究发现，近十年中，宁夏盐池县植被指数（NDVI）明显改善，生态工程恢复植被成效显著，但植被可持续性的关键仍然需要处理好与气候承载力和适应性的关系。陈芳森博士等人研究结果表明，人为因素是导致新疆荒漠化问题严峻化的主导因素，并建议从战略高度认识防治荒漠化的意义，根据南疆、北疆、东疆不同特点，依靠科技走预防、治理兼顾路线，积极与上海合作组

织协作防治荒漠化，关注当地民众权益，处理好国家、企业、民众利益关系。

牧区是荒漠化的敏感区域，牧区生产模式和经济政策效果是近年来中国学术界争论的焦点之一。达林太教授和郑易生教授多年的合作研究结果表明，内蒙古自治区草原“普遍过牧”的定论是建立在错误的方法论基础上的，其错误源于将本来适用于依赖天然草地养畜的承载量的概念硬套在那些“不完全依赖草地”的家畜身上。这显然忽视了几十年来草原上畜牧业生产模式发生的巨大变化。过牧的认定对政策影响极大，不根据不同地区的特点对牲畜数量与草地面积的关系进行具体分析，就难以产生因地制宜的对策。李庆禄教授等人对科尔沁沙地地区草原生态移民典型居民点翁牛特旗阿什罕苏木珠日干格日村、巴林右旗西拉沐沦苏木达林台村和科尔沁左翼后旗巴胡塔镇东巴胡塔村进行了实地调研，发现解散游牧集体、草畜双承包以及对草原的开垦是造成草原退化和荒漠化的真正原因，并对防治荒漠化提出对策，建议在科尔沁沙地拆除围栏，整村甚至跨村的合并牧场和畜群，恢复集体游牧，并推行退耕还牧。

在防治荒漠化方面，胡霞教授等人从环境教育角度指出，中国防治荒漠化在环境教育方面的重视度不够，环境教育偏重理论方面，同时在立法环节较为薄弱，认为加强环境教育是根治包括荒漠化在内的环境问题的好办法，并介绍了日本仁淀川在该领域的成功经验。O. S. Abduraimov 简要介绍了一种郁金香的种子生产在克孜勒库姆沙漠的分布情况。J. Karshibaev 博士研究指出，在一些多年生物种中，种子繁殖和营养繁殖的结合使之具有适应干旱的优势。樊艳敏和朱立君介绍了通榆县环保志愿者协会防治荒漠化的运作机制，指出在生态恢复、环境教育、可持续农业和和谐社区建设的综合防治荒漠化工程建设基础上或可实现荒漠化地区的可持续发展。胡跃高教授等人应用系统科学理论和系统工程方法建立了荒漠化工程“金字塔”控制模型并在此基础上提出了防治荒漠化的系统工程解决方案。

此次会议不仅对荒漠化的定义、荒漠的形成以及热点区域的荒漠化问题进行了深入探讨，尤其对于防治荒漠化的研究也有了新的突破。会议的召开和论文集的出版得到了原中国科协副主席刘恕先生、中国系统工程学会草产业专业委员会李毓堂会长等前辈，中国治理荒漠化基金会张剑鸿理事长，中国农业大学农学与生物技术学院领导的支持。日本岛根大学名誉教授保母武彦先生为会议召开发来贺信。气象出版社张锐锐编辑对于文集的编写和出版给予了大力支持和协助。中国农业大学农学与生物技术学院和中国防治荒漠化工程研究中心多位老师和研究生参与了本文集的汇编、整理工作，在此一并表示感谢。

中国防治荒漠化工程研究中心

2014.10

Introduction

June 17th, 2014 was the twentieth World Day to Combat Desertification and Drought, when the experts being from Russia, Uzbekistan, Iran, Nigeria and China attended the "Third International Specialty conference on Science and Technology for Desertification control" in Beijing. The conference set four issues including "Understanding of desertification", "Regional problem of desertification", "Pastoral and desertification," and "Combat Desertification" to research and discuss, aimed at the prevention of desertification perspective to understand desertification, and guide action . Experts proposed to build a project to combat desertification in Central Asia together with the Shanghai Cooperation Organization country members jointly, and wrote an advice report to the Zhongnanhai.

After the meeting, we selected the main papers of participants to publish this anthology, including 5 greeting materials for the conference opening ceremony, 16 research papers, 2 abstracts, together with the full text of "jointing Shanghai Cooperation Organization country members to build a project to combat desertification in Central Asia—the third International Science and Technology Conference to Combat Desertification recommendation report".

How to understand the problem of desertification correctly, the Professor Shurun Liu as a grassland ecologist, pointed out that the problem of human-caused and natural desertification should be discussed separately, human-caused desertification is the real desertification, its essence was diversity loss; however, the simplistic, extreme and anti-traditional culture of thought was the most horrible. Huailong Song's results showed that the formation of great salt desert because of the drought in the ancient Mediterranean region resulted in the formation of the Sahara desert and the Arabian Peninsula desert directly. Salt desert and saline (mixed) dust storms had played an important role on Earth Evolution, changes in the global environment, the world's major desert landscape and the evolution of the birth and life, especially in terms of formation of hominids.

The regional desertification research covered a wide scope. The Corresponding Member of the Russian Academy of Sciences, A. K. Tulokhonov together with his colleagues studied the part of the alliance from Mongolia arid climatic zones in remote sensing and GIS technology based on the normalized difference vegetation index (NDVI), and the results showed that the vegetation degradation of the area expanded badly in recent years, should be strengthened grazing and scientific management. Director of the Siberian Branch of the Russian Academy of Baikal Resources Management Institute, Endon Zh. Garmaev made a cautious conclusion that a significant change of the volume of river runoff of the Baikal basin, therefore, a tributary to the lake itself, is not expected by the middle of the XXI century. Enkh Amgalan being from the Mongolian Academy of Sciences Institute of Geography reported that the aggravation of ecosystem instability, climate anomalies, storms and drought disaster, had an adverse impact on mining and agriculture, exacerbated desertification and grassland degradation, and led to a series of social problems in Mongolia. Juanle Wang and Qing Liu using the latest research data of land use and cover in 1990 and 2010 analyzed spatial and temporal distribution of desertification in Mongolia and the region desertification development characteristics between 1990 and 2010 with the grid computing method, their results showed that Mongolia had a rapid growth of urban area, a rapid change of land, a large number of forest and grassland broken, a significant increase in the area of bare ground, while some bare land degraded to sand nearly two decades.

D. A. Darbalaeva of the Siberian Branch of the Russian Academy of Baikal Resources Management Institute showed that Mongolia Orkhon alliance's standard of living was higher than that of other alliance, its desertification was such increased that its ecological and economic situation was not optimistic. Professor Naiping Song indicated that the Vegetation Index (NDVI) in Yanchi county significantly improved nearly a decade, and the ecological engineering restoration of vegetation was remarkable, but the key to the sustainability of the vegetation still need to deal with the relationship between climate bearing capacity and adaptability. Dr Fangmiao Chen *et al*. results showed that the human factor is the dominant factor to cause the desertification problem of Xinjiang, suggested to understand the meaning of combat desertification from a strategic height, according to the different characteristics of southern, northern, eastern Xinjiang, took the prevention, control both route relying on science and technology, cooperated with the Shanghai Cooperation Organization actively to combat desertification, concerned the interests of local people, and deal with the state, enterprises, the public interest relationship.

Pastoral is a sensitive area for desertification, the effect of its mode of production and economic policy are one of the academic debate focuses in recent years. Professor Dalintai and Yisheng Zheng research results showed that the conclusion that "universal overgrazing" was in the Inner Mongolia steppe was based on an incorrect methodology, the error stemmed from the otherwise applicable to rely on natural grassland livestock carrying capacity the concept rigidly applied in those "not totally dependent on the grass" the animal bodies. Obviously, it ignored the tremendous of production pattern changes occurred on grassland livestock in the past decades. The conclusion of overgrazing had a great impact on policy. For example, not a detailed analysis of the relationship between the number of livestock and grassland area of the characteristics of different regions, it was difficult to produce measures to local conditions. Professor Qinglu Li conducted an investigation in two villages of Wengniute Banner and a village of Horqin Left Back Banner where is a typical residential area of grassland ecological migrants in the region of Horqin Sandy, and found that the real reason for prairie grassland degradation and desertification was the dissolution of the nomadic group, double-contractors as well as livestock reclamation, came up with strategies to combat desertification, and proposed to remove the fence in Horqin sandy region, to merge the whole village pasture and herd even across the village, to turn farmland to husbandry.

In the management of desertification aspect, Professor Xia Hu *et al.* pointed out that we ignored the importance of the environmental education in our country combating the desertification, our environmental education emphasized on theory more. Meanwhile, they thought that our legislative session was weak, as well as a proper way to solve the radical environmental problems including desertification was the environmental education improvement, they also introduced a successful experience from Jen Yodogawa in this field. O. S. Abduraimov briefly described the distribution of a tulip seed production in Kyzylkum desert. Dr J. Karshibaev noted that seed propagation and vegetative propagation combination so that it has the advantage of adaptation to drought in some perennial species. Yanmin Fan and Lijun Zhu introduced the operating mechanism of Environmental Protection Volunteers Association to combat desertification in Tongyu county, said that we could achieve sustainable development in desertification area through ecological restoration, environmental education, and comprehensive construction of sustainable agriculture and the construction of a harmonious community. Professor Yuegao Hu *et al.* established a "pyramid" control desertification project model using systems scientific theories and engineering approach and proposed systems engineering solutions to combat desertification on this basis.

This conference not only concluded the definition of desertification, the formation of desertification as well as hot desert area in-depth discussions, but also we obtained a new breakthrough for desertification prevention study especially. Meetings and the publication of proceedings has been supported by Mr. Shu Liu, ex-vice chairman of the China Association for Science, Mr. Yutang Li, chairman of China Systems Engineering Society of Professional Committee of grass industry and other seniors, Mr. Jianhong, director of Chinese Foundation for Desertification Control, school leaders from College of Agronomy and Biotechnology of China Agricultural University. Mr. Takehiko Hobo, Professor of Japanese Shimane University, sent a congratulatory letter to the meeting. Ruirui Zhang, editor of Meteorological Press, provided assistance for the writing and publishing of anthology. Many teachers and students from College of Agronomy and Biotechnology, China Agricultural University and the China Research Center to Combat Desertification involved in the compilation of this anthology, finishing work. We express our gratitude to all together.

China Center for the Management and Prevention of Desertification
2014. 10

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Spatio-Temporal Dynamics of Vegetation Cover on the Baikal-Gobi Meridional Transect on the Basis of Time Series Ndvi and Field Investigations

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A A Ayurzhanaev[1] Zh B Alymbaeva[1] Ts Chimeddorj[2]

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Abstract: Model polygons located in dry subhumid, semiarid, arid and extra-arid climactic zones in Russia and Mongolia were considered for the investigation of vegetation dynamics. For these polygons plots of the NDVI temporal variation and NDVI maps of its spatio-temporal dynamics on the basis of Landsat TM imagery were constructed. The full-scale landscape indication of the selected NDVI areas was conducted. This indication is supported by the analysis of vegetation by environmental groups for drought resistance. The vegetation digression during this period is traced across almost the entire territory of the selected polygons.

Keywords: desertification; vegetation degradation; dry subhumid; semiarid arid extra-arid; climactic zones; Landsat; NDVI; landscape indication; euxerophytes

Introduction

Over 85% of the Mongolian territory is located in dry climatic zones: dry subhumid, semiarid, arid, and extra-arid. According to the definition established by the United Nations Convention to Combat Desertification (1994), the degradation of land in these climatic zones results from desertification. While developing, the processes of desertification subsequently affect and damage the following geosystem's components: vegetation, soils and underlying rocks, and forms of the landscape. The vegetation is the first to be affected by desertification [4], so we are going to focus on studying its changes as a result of this degradation phenomenon.

The aim of this work is to reveal and analyze changes in the vegetation cover of Russian and Mongolian dry climatic zones, using a variety of field and remote sensing studies.

Materials and Methods

Territory of study. Over the years of working on the project "Development of desertification complex indication system for modern Siberian and Central Asian ecosystems and monitoring system evaluation"under the Program of fundamental scientific research, Presidium of Russian Academy of Sciences (2008—2013), a number of model monitoring polygons has been established in different latitudinal zones of the Mongolian territory according to the longitudinal transect (105°E~107°E, 51°N~44°N). These polygons include a wide range of territories with dry climatic conditions. This work revealed the main factors, agents, and trends of development for desertification processes in different climatic zones. Two model polygons were considered in Central Mongolia: (1) the Kharaa River downstream basin and the Orkhon River right feeder (territory of the Selenge and Darkhan-Uul aimags); (2) the central part of Dundgovi aimag (Mid-Gobi). The first polygon is situated in a semiarid climatic zone with grassland and bunchgrass steppes. The second is located in an arid climatic zone; from botanical and geographical points of view, its main feature is the prevalence of desertified steppes. To study biophysical parameters of vegetation, using the normalized difference vegetation index NDVI, three main areas were chosen: two of them are situated on the territory of Kharaagol, monitoring the model polygon, and the third one is in the Mid-Goby polygon.

Study period. The temporal dynamics of the vegetation was estimated using archive geoportal data of the Russian Space Research Institute, Russian Academy of Sciences (IKI RAS) for the period of 2001—2013. NDVI areas were mapped with satellite images for the first half of September for a 20-year period from 1990 to 2011. The selection of the study period is explained by the availability of the Remote Sensing data.

Landsat multispectral data. Necessary multispectral images made by the spectroradiometer TM of the Landsat-5 satellite were downloaded from the geoportal of the US Geological Survey, using GloVis search (http://glovis. usgs. gov) for the selected polygons (for Kharaagol polygon path=132, row=26; for Mid-Goby polygon path=131, row=28). The spatial resolution of images was 30 meters per pixel. All images must be done with a completely cloudless sky (0%), be of high quality (Qlty=9), and have a sufficient level of image preparation (level L1T, ortho transformation, radiometric, and atmospheric corrections).

Digital elevation model (DEM) SRTM. Height radar data of the DEM SRTM (Shuttle Radar Topography Mission) were downloaded from the FTP-server of the U S Geological Survey. To conduct relief morphometric analysis, a number of the corresponding morphometric maps were established and analyzed (along with the data of field observations): hypsometry, slopes, and aspects. Also, topographic modeling of three-dimensional images was conducted.

Normalized Difference Vegetation Index. Over the last decades, remote sensing methods, especially satellites, have provided opportunities to organize immediate vegetation monitoring. Of particular importance in the establishment of a system of remote sensing monitoring is the possibility of organizing completely automated satellite data processing. Over the last years, such technologies were actively being established and developed in IKI RAS. They allowed the creation and actualization of the archive of constant satellite observations on the territory of Russia and adjoining states for the period from 2000 until the present[7]. The Baikal Institute of Nature Management SB RAS and IKI RAS conduct collaborations in the area of using informational technologies and remote sensing methods to solve scientific problems of monitoring the state and dynamics of vegetation cover. The basis of automatized technologies established by IKI RAS is the analysis of the temporal variation of the Normalized Difference Vegetation Index (NDVI)[8]. The NDVI is based on the analysis of differences in the chlorophyll reflection on red and near infrared zones of the electromagnetic spectrum, and it gives a numeric value for characteristics and estimates of the spatial variation of vegetation cover biophysical parameters.

While identifying vegetation species, Mongolian[3] and Buryatian[1] key to identification of plants were used.

Results and Discussion

Dry subhumid climatic zone. Results of field investigations on model and key sites in the Russian part of the intermountain hollows of the Selenga river basin indicate that in general there is a tendency to reduce the development of processes of land degradation and desertification. Primarily, this is due to the reduction of agricultural exposure to landscapes connected with the withdrawal of many unproductive lands. Most clearly this trend occurs within the dry subhumid climatic zone. On fallow lands braked 10~20 years ago is an active reforestation of pine natural habitats (Pinus sylvestris). These habitats existed here before plowing and forest clearance. This process takes place in the forest-steppe zone and helps reduce aridization of hollow geosystems. At many sites of dry subhumid climatic zone that were active 7~8 years ago erosion and aeolian landforms is regrown.

Semiarid climatic zone. Among the desertification types discovered by FAO-UNEP [11] on the greater part of the Selenga River basin, especially in its Mongolian part, the vegetation cover degradation is the most widely spread. It is revealed in structural changes of the steppe, forest steppe, and pasture phytocenosis, the successions of their species by synanthropic ones, and decreased projective cover and grass height [9]. In places with the highest development of degradation and land desertification processes caused by poorly populated pine *Pinus sylvestris* L. and drought resistant elms *Ulmus pumila* L. in the Kharaagol sandy area (absolute height values of 735-815 m).

According to the scheme of the landscape and the ecological district division[5] located in the central part of the Selenge River basin, the Kharaagol model polygon is situated in an area of high ecological intensity, caused by both natural and anthropogenic factors. Let us consider the key site of 19.16 km^2 situated in the northern part of the Kharaagol polygon, 3 km southeast of the Darkhan city. The biggest part of this site, located on the separated slopes of low hill terrain of the Orkhon-

Kharaagol interfluve (maximal height marks are 810～870 m), has steppe caragana-cereal-fringed sagebrush (*Artemisia frigida-Leymus chinesis-Caragana microphylla*) vegetation. As geobotanical studies have shown, the small-leaved caragana *Caragana microphylla* (Pall.) Lam. dominates in the projective vegetation cover (17%～20%). Fringed sagebrush, *Artemisia frigida* Willd. is also widely spread, as well as Chinese wild rye *Leymus chinensis* (Trin.) Tzvelev, etc. Most of the land is used as pasture.

Using access to the satellite monitoring service 《Vega》 to monitor the vegetation condition, average NDVI curves were built for the Kharaagol key site for the first 13 years of the twenty-first century[8]. Some nonuniformity of the NDVI distribution was observed throughout the years, caused by different climate conditions. It should be pointed out that in 2007, 2008 and 2012, the NDVI values were rather high, 0.6, which is related to the higher values of temperature and moisture regime during the summer months of these years (the service 《Vega》 allows to carry out the joint analysis of NDVI and meteorological parameters). The average summer value of the NDVI in 2011 was 0.45 for this site, which proves sparse vegetation during this year (Fig. 1).

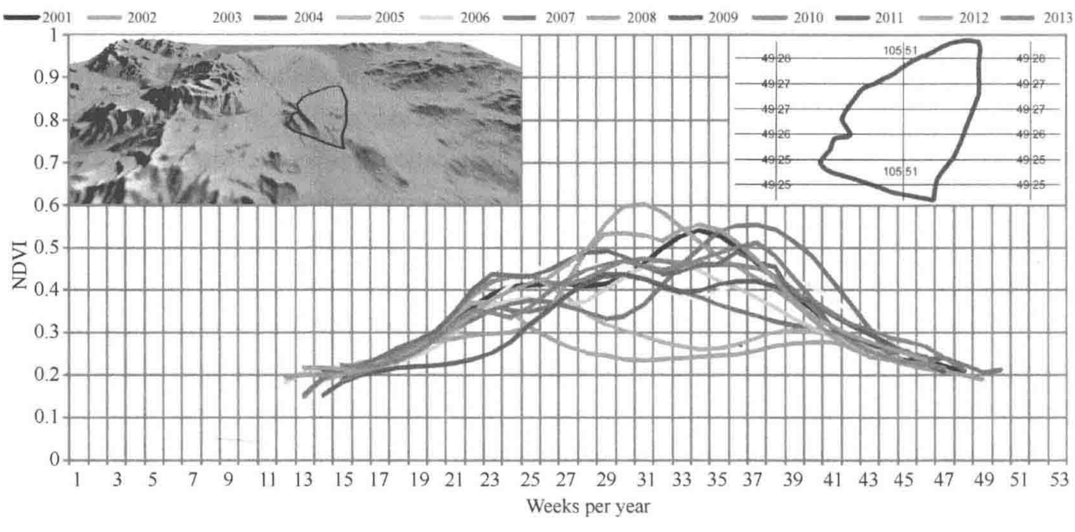

Fig. 1　Variations of averaged NDVI on 2001—2013 for the north area of the Kharaagol polygon. The upper-right inserted image is the scheme of the site; the upper left inserted image is a 3D-view on the base of DEM SRTM

NDVI indices were calculated and visualized for the territory of the key site, based on Landsat TM multispectral space images made for September data of a 20-year difference: 1990 and 2010 (Fig. 2). Images were processed with the program complex ENVI v. 4.7 (www.ittvis.com/ENVI), which is well known as a full-functional solution for the visualization, processing, and analysis of remote sensing data. There are two channels of TM spectroradiometer: channel 3 is red, channel 4 is near infrared. While conducting field measurements, GPS-tracks were prepared for the site's borders, which were later converted into vector shape files, functioning as a mask for marking the borders of the sites. The NDVI areal mapping with a 0.1 pitch was conducted only within the limits of marked closed polygons.

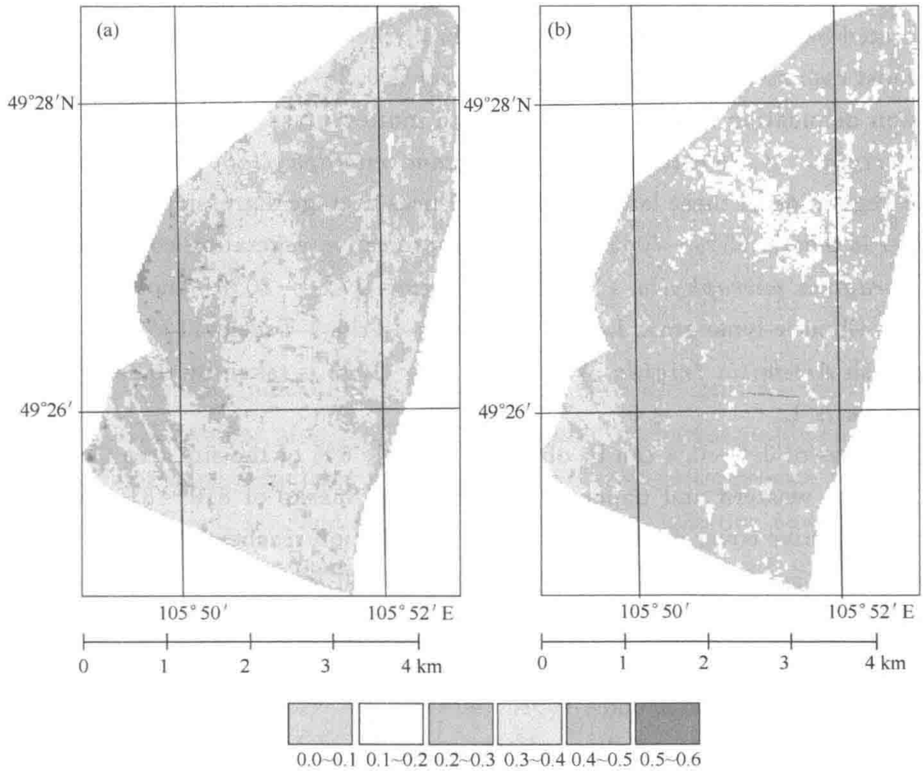

Fig. 2 NDVI maps for the north area of the Kharaagol polygon:
a) processed image Landsat TM for September 17, 1990; b) September 8, 2010

Comparing the NDVI images, there is a digression of vegetation conditioned mainly by a high pasture load. In September of 1990, most of the site (53%) had 0.3~0.4 NDVI values, while in September of 2010, 86% of its area was 0.2~0.3 (Table 1).

In the field expedition studies of 2011—2013, the in-situ landscape indication of NDVI areas with different values was conducted. The natural and anthropogenic factors of the dynamics

Table 1 Classification on NDVI graduation for the north area of the Kharaagol polygon

NDVI	September 17, 1990		September 8, 2010	
	Area, km²	Area, %	Area, km²	Area, %
0.0~0.1	0.00	0	0.01	0
0.1~0.2	0.12	1	1.58	8
0.2~0.3	5.44	28	16.45	86
0.3~0.4	10.19	53	1.12	6
0.4~0.5	3.30	17	0.01	0
0.5~0.6	0.12	1	0.00	0
Total:	19.16	100	19.16	100