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Environmental Research in Cambridge A Study of Sustainable Development in Pastoral Inner Asia: The ECCIA project.

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Abstract

This paper provides a very brief introduction to the wide range of research on environmental change at Cambridge University. It goes on to describe the findings of one such research effort in more detail; the Environmental and Cultural Conservation in Inner Asia research project carried out by the Mongolia and Inner Asia Studies Unit.

This project made use of the expertise of both social and environmental specialists to carry out a comparative study of the Inner Asian steppe and its peoples. The paper reviews some of the major findings of this research. It compares the numbers of livestock supported by the pastoral economies of Inner Asia before and after collectivisation, and contrasts the pastoral sectors of Buryat and Chita with the more mobile pastoral systems of Mongolia and Tuva, which appear more sustainable. It notes that the case-studies carried out by the project in Buryatia and Chita suggest that the conditions for the emergence of a sustainable market economy are largely lacking, and that so far attempts to introduce one have been unsuccessful. It questions the wisdom of continued top-down planning in an attempt to apply inappropriate western economic models, and suggests locally-developed plans for pragmatic agricultural development, learning from the experiences of neighbouring regions of Inner Asia.

Introduction: Environmental studies in Cambridge and the ECCIA project

Research on the environment is being carried out in a wide range of different department of Cambridge University. The Committee for Interdisclipinary Environmental Studies (CIES) compiles records of these initiatives and their last register, issued in 1996, lists over 570 research projects at the doctoral and postdoctoral level. These are found in departments as diverse as Zoology and Economics, and it would be quite impossible to attempt a comprehensive overview in a paper of this sort. However, I will mention two initiatives that may be of particular interest to readers of this collection before describing some of the research findings of the project I worked on. Dr Gareth Rees, the Assistant Director of Research at the Scott Polar Research Institute, heads the institute's Remote Sensing Group, and his team explores ways of using satellite imagery to study the arctic environment. The group is particularly concerned with the study of the Russian arctic, monitoring the effects of environmental damage such as oil spills, ground and air pollution by investigating the discernable impacts on vegetation growth. The group has good working relations with Moscow University and research centres in Canada and France, but not, as yet, in Japan. They make use of an interdisciplinary approach, incorporating the skills of social anthropologists such as Piers Vitebsky, who has done fieldwork with reindeer herders in Siberia. This year a new centre for Environmental Studies is being established by Cambridge University's Geography department, under Professor

Andrew Cliff. The new centre plans to open by October 2000, and will have a strong emphasis on the use of GIS and remote sensing technology.

A great deal of environmental research in Cambridge is carried outside the University, the World Conservation Monitoring Centre and the British Antarctic Survey are both based in Cambridge and East Anglia Polytechnic University also supports a wide range of relevant research.

The Mongolia and Inner Asia Studies Unit (MIASU) is a multi-disciplinary postdoctoral research centre devoted to regional studies, particularly social anthropology. We have a specialist library and database, and about a dozen members at any given time, including a number of doctoral research students and academic staff. In 1999 we published the last of a series of books and papers presenting findings from a research project on Environmental and Cultural Conservation in Inner Asia (ECCIA) which the MIASU conducted in 1991-96.

The project was directed by Caroline Humphrey and was conducted in collaboration with a number of Inner Asian research institutions, with the aim of comparing the environmental, cultural, and administrative conditions throughout Inner Asia, in an attempt to learn lessons for the sustainable development of pastoralism in the region.

The sustainable development of Inner Asia, if it is to be achieved, will depend upon a sustainable and productive livestock sector. Most of the region is grazing land, poorly suited to crop raising. The different regions of Inner Asia - Mongolia, Inner Mongolia, Buryatia, Tuva and Xinjiang - share very similar steppe and forest ecologies, and a common continental climate. In the past the different parts of Inner Asia supported very similar rural economies, however, the twentieth century has seen these pastoral areas have been developed in very different ways by Russian, Mongolian and Chinese governments. These different experiences represent experiments, if you will, in the sustainable development of the Inner Asian environment. The ECCIA project set out to conduct a comparative investigation of these different experiences in managing the pastoral economy in order to be able to evaluate the variety of reform options being considered, and projecting their likely effects on the societies and environment of the Inner Asian steppe.

The project brought together local social and environmental scientists from Buryatia, Mongolia, Inner Mongolia and Xinjiang, and Tuva. The Project designed a strategy that combined qualitative and quantitative analysis. To obtain both in-depth knowledge and a wide understanding of major processes we used detailed case studies carried out in person by each researcher, in conjunction with comparative overviews of topics such as land-use, institutional change, mobility, social organisation, and settlement patterns. These were carried out in ten primary and two secondary sites.

The project also built a GIS and compiled a range of geographic information on the region. Although the GIS proved to be an interesting and attractive technology, we actually found it to be of limited use when it came to understanding the situation on the ground. The in-depth studies of chosen rural communities turned out to be essential. A clear picture of the environmental situation required, for example, a detailed understanding of the local systems of pastoral management and socio-economic conditions.

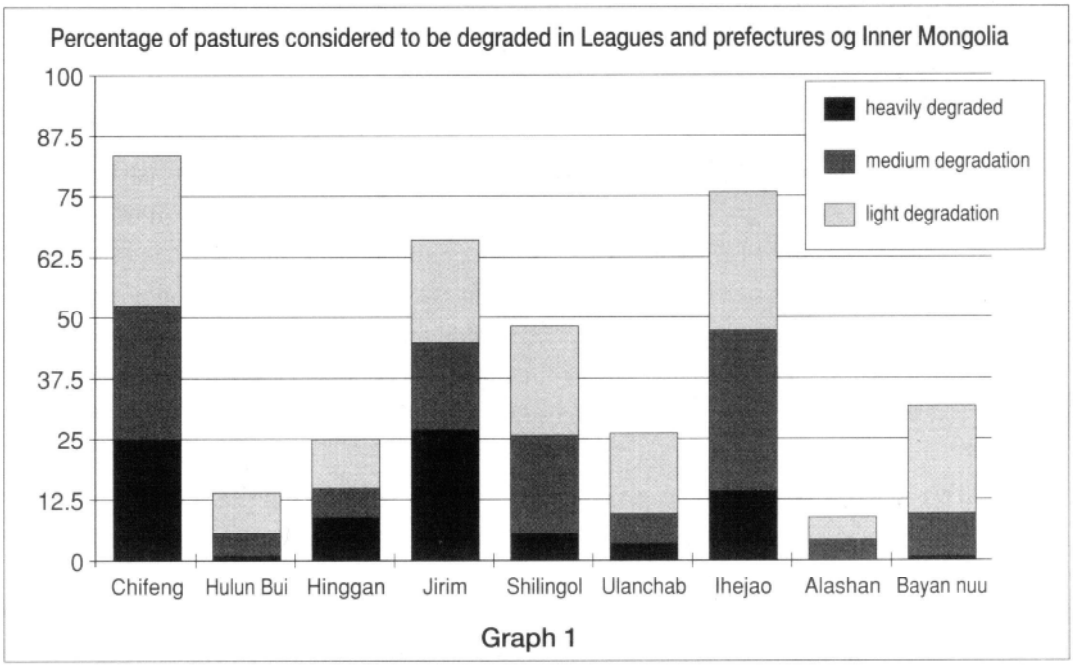
Sustainable pastoralism in Inner Asia

It seems that pasture degradation in certain regions of Inner Asia is severe and that current livestock production practices are unsustainable in some places, such as in the Barguzin valley (Buryatia). This raises the general question of 'sustainability' and how we use the term. As Arrow et. al. have observed (1995) sustainability, like 'carrying capacity', is not a fixed static or simple relation - for either animal or human populations.[1] It is contingent on technology, preferences, and the structure of production and consumption. It is also contingent on the ever-changing state of interactions between the physical and biotic environment. Environmental sustainability is related to ecosystem resilience: economic activities are sustainable only if the ecological resource-base on which they rely are resilient. In any one region there may be multiple locally stable equilibria, and resilience is a measure of the size of disturbances that a system can absorb before it flips over from one equilibrium to another (Arrow et. al. 1995: 4). Ecological resilience is difficult to measure and varies from system to system, but there are signals that provide early warnings of essential ecological changes. We thought it was useful to refer in our work both to local (herdsmens') perceptions of environmental degradation and to the assessments of regional specialists. Among the former, with reference specifically to pasture conditions, we list: marked reduction in the diversity of grass species, observed diminution in the growth of grasses over the annual cycle, increase in unpalatable grass species associated with overused pastures, decrease in density of vegetation distribution, reduction in water levels in rivers, and expansion in sandy areas and dunes. Herders and local specialists also make assessments about the number of years required to reconstitute a flourishing pasture after it has been turned over to agricultural use, and after specific types of degradation. With regard to the assessments of regional specialists, we also took account of professionally produced models of carrying capacity for pastures of given types (See Gomboev et. al 1995).

These two methods of assessing sustainability each have their advantages and disadvantages. The herdsmens' judgements are specific and reliable, but they do not enable us to judge whether a given pastoral system is sustainable or not. The professional specialists' models are based on plant productivity mathematically abstracted over a whole region and are subject to a variety of problems.[2] However, they do enable analysts to use such models to make judgements about sustainability in given sites.

The E.C.C.I.A. project mapped livestock density in Inner Asia, based on local government statistics for each of the regions, using districts of approximately the same geographical size.[3] These maps show relatively high concentrations of domestic animals in much of Inner Mongolia, notably the south-eastern areas (where there are also substantial amounts of agricultural land), such as Jirim aimag and Chifeng prefecture. There appears to be noticeable impact upon vegetation cover in these two districts, probably linked to both agricultural and pastoral land-use.[4] These regions also have some of the highest levels of reported pasture degradation.

Much of the pasture land in Buryatia and Chita also has high stocking levels, and in general these regions also have both static pastoralism and the most significant problems of pasture degradation. Mongolia seems to have lower livestock densities, in general, than other parts of the region. Interestingly, however, the relatively well-watered regions of central Mongolia have stocking



Graph 1

levels that are comparable with those of Inner Mongolia and the Russian districts. Such Mongolian areas also have relatively high levels of annual precipitation (300 to 500 mm), but this is little higher than the eastern parts of Inner Mongolia. It appears, however, that these parts of Mongolia have few if any of the problems of pasture degradation and desertification that are reported in Inner Mongolia. It is significant that the most densely stocked regions of Mongolia are mountainous, particularly parts of the Hangai range. These areas are not noted for high pastoral mobility, indeed they tend to have shorter annual movements than much of the rest of Mongolia (see Sneath 1999 b). However, high stocking rates are also found in the mountainous west of the country, where there are some of the longest annual movements. It seems likely that the range of climatic and pasture conditions that can be found in more mountainous regions tends to allow for high numbers of livestock.

Taken together with the findings from the case study sites, the comparison with Mongolia suggests that the severe problems of pasture degradation reported in areas of Inner Mongolia may have more to do with the practice of agriculture and the low-mobility pastoralism practised in these regions than to absolute numbers of livestock per se.

In Russia (Buryatia, Chita, and Tuva) there is a more patchy distribution of high density livestock regions. One of the most interesting findings here is that while the Buryat and Chita case-study sites appear to be suffering from extremely serious problems of pasture degradation, the Tuvan site is not.[5] Tuvan stocking levels are lower, but not markedly so. This would suggest that the Tuvan pastoral strategy, being more mobile and more closely resembling that of Mongolia, is much more sustainable. Unfortunately, much of the data we have is at the aggregated level of analysis of raions; however, at this level they suggest that Tuva has achieved comparable livestock densities to Buryatia and Chita, at a fraction of the environmental cost.

An Overview of 20th century changes in pastoral sectors .

A comparison of the histories of collectivisation of the pastoral economies of the different parts of Inner Asia shows some interesting parallels.

In Inner Mongolia and Buryatia, for example, it seems that relatively high numbers of livestock were supported before collectivisation. In both regions there has also been an important increase in the amount of land cultivated for crops, (although even today the area amounts to about 5% of the total area of the region).[6] The amount of pasture now in use in Inner Mongolia is less than early this century, and grazing pressure on the grassland is clearly likely to be greater as a result. However, it is interesting to note that the pre-revolutionary economy supported as many animals (as measured by standard stocking units) as modern Inner Mongolia - around 70 million SSUs.

In Inner Mongolia today there is a very strong perception that the pastures are saturated, and that this overstocking is the cause of widespread grassland degradation.[7] Recent work by Inner Mongolian specialists suggests that as much as 35.6% of Inner Mongolian grassland has been degraded and attributes this to overgrazing.[8] It is interesting to note, then, that in terms of SSU's there has not been a dramatic increase over pre-revolutionary 'stocking levels' at all.

This is not an isolated case. In the pre-revolutionary period the pastoral sectors of Buryatia and Tuva also supported something like the same numbers of animals (measured in standard stocking units) as they do today. This raises a number of important questions with regard to the perceived problem of overgrazing. If, for instance, Inner Mongolia, is facing an acute and historically unparalleled problem of environmental damage in many regions as a result of overgrazing, then we cannot assume that this is because it now supports an unprecidentedly high number of animals. In each case the pastoral regions under study have experienced a dramatic increase in the numbers of sheep and goats ('small animals'), and a stagnation, or in some cases (such as Inner Mongolia), a decline in the numbers of the 'large' domestic animal species, principally horses, cattle and camels.

We observe two processes that may be causally related. Firstly a general shift in the composition of the burden on the pastoral regions of Inner Asia, from large domestic species to sheep and goats. Secondly, a growing perception among both herdsmen and specialists that the grassland has experienced an increasing amount of degradation. In Inner Mongolia in particular, there appears to be serious environmental degradation in some regions, which is attributed to overgrazing. This would suggest that it is the change in species of domestic animals, or some other aspect of herding practice was to blame. It may be that the greater numbers of sheep and goats generate different and more generally damaging effects on the grassland environment than an equivalent number (measured in stocking units) of large animals (horses, cattle and camels). This conjecture is supported by the developments in Buryatia in the 1990s, where collectives are faced by very widespread problems of soil degradation. The numbers of sheep has been drastically reduced in the last decade, partially because the pastures cannot support them, and partially because the farm management believes that sheep have a particularly damaging effect on the grassland.

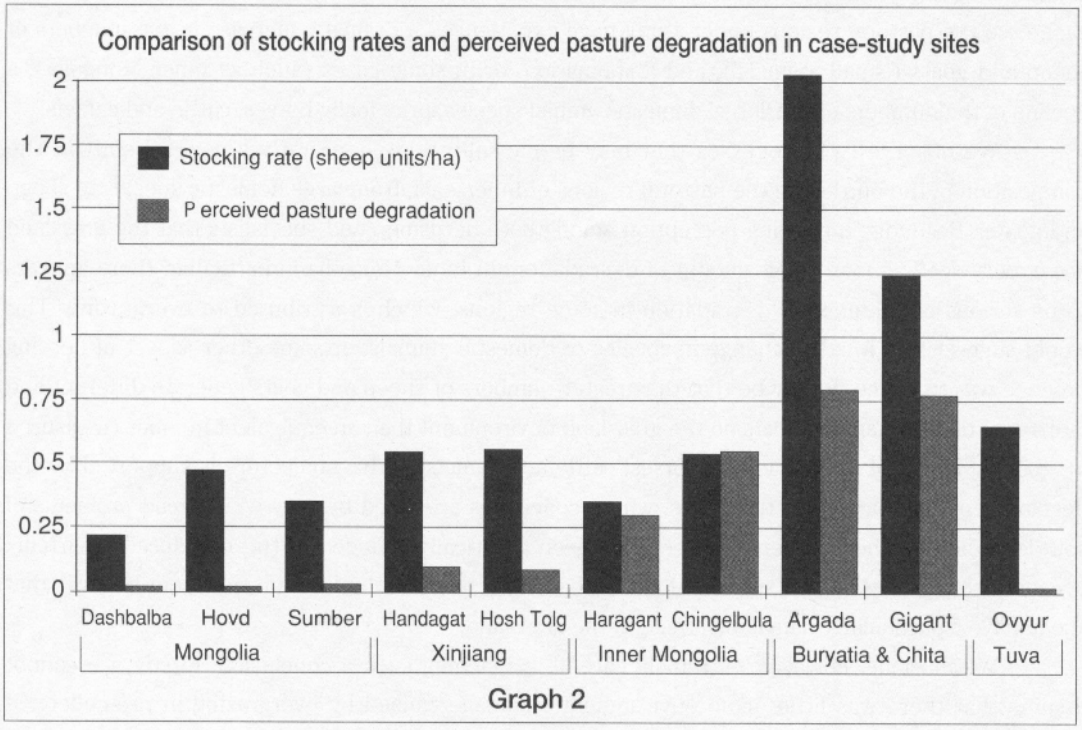
We must be, however, extremely careful in reaching such a conclusion. Firstly, we cannot assume that there was little or no environmental damage caused by overgrazing in pre-collective times. What might be conceived of as the recent problem of degradation of pastures may be part of a

much longer cycle. Grassland ecosystems are a product of the way they are grazed by different species, and what is perceived as 'environmental damage' might be an example of environmental change in response to a different balance of domestic animals in the systems. Secondly, assessing the situation in terms of total numbers of animals (by means of an artificially constructed 'standard stocking unit') may not be as relevant for grassland degradation as the understanding the local management of herding (e.g. herd sizes, over-reliance on certain pastures, and what use is made of local micro-resources such as water-sources, winter sheds etc.).

Pasture degradation and herd mobility

Examining the findings of the case-studies themselves, it appears that stocking rates alone are a poor guide to the levels of perceived pasture degradation, except at the extremely high concentrations found in the Buryatia and Chita sites, as shown in graph 2.

Three case-study sites were chosen in Mongolia, Dashbalbar in the eastern aimag (province) of Dornod, Hovd in northwestern Uvs aimag, and Sumber in southern central Mongolia. In Xinjiang two study sites were chosen in the north of the region, Handagat in Altai district and Hosh Tolgoi in Hoboksair district. In Inner Mongolia case study sites were selected in Haragant in the northeastern region of Hulun Buir, and Chingelbulag in northern central Shilingol. Two sites were chosen in the Buryat region of the Russian Federation, Argada in Buryatia and Gigant in Chita. Finally one Tuvan site was selected, Ovyur.



Graph 2

While in Argada and Gigant there are both high stocking rates and very severe problems of perceived pasture degradation, Ovyur, in Tuva, has a stocking rate that is higher than that of many other sites, and yet almost no reported pasture degradation. The State Farm at Solchur in Ovyur does, however, have a relatively mobile pastoral system. By contrast, the increasingly sedentary Haragant site in Inner Mongolia actually has a comparatively low stocking rate, and yet it also has serious problems of perceived pasture degradation.

It appears that in the steppe case-study sites the amount of livestock mobility is a better guide to the amount of reported degradation of pastures, than the stocking rate. The comparison of the pastoral systems practised in the case-studies seem to support the widespread perception among herders that a low amount of livestock movement was a major cause of pasture degradation. One of the most significant changes in the pastoral systems of Inner Asia has been a reduction in the amount of mobility of certain sectors of these pastoral economies. This is more fully discussed in Humphrey and Sneath (1999), but it appears that Mongolian and Tuvan pastoralism seems to have retained mobility to a greater extent than the other parts of Inner Asia, and this suggests that mobility may have an important part to play in prevention of pasture degradation.[9]

The allocation of pasture land to individual households that is being carried out in Inner Mongolia is historically unprecedented in Inner Asia. It raises the question as to what extent such allocation will continue to reduce the annual movement of livestock in the region, as this policy does seem to have reduced mobility in the case-study sites.

Pastoralism, mobility and institutional scale

All over Inner Asia, the luxuriant grass produced in summer, which is the season of rain, can support larger numbers of livestock than the dry and sometimes snow-covered vegetation of winter. Pastoralists have developed two main techniques to deal with this problem. In the steppe regions, which includes most of the area covered by the Project, frequent movements to flexibly-chosen pastures enables herders to make best use of the grasses available in a given year. This is no longer possible in many regions where pastoral mobility has been reduced, but in some areas the winter otor (short pasturing trips away from the settlement) continues to be particularly important and useful for the more rapid-moving species, such as sheep, goats and horses. During the last fifty years there has been an increased use of natural hay (mown in summer to feed the animals during winter), but a much older strategy for the intensification of production is essentially to make more frequent and longer seasonal migratory movements.

Historically, mobile systems of pastoral land-use in Inner Asia were based upon the flexible use of pastures by pastoralists within an established framework of use-rights, but this access was very clearly subject to regulation by district authorities. Before the collective period large-scale pastoral operations - involving the wide movement of large herds under the care of specialist herders - were organised by wealthy nobles or monastaries who also controlled rights to land. These local authorities also operated a framework of jural rights over the commoners who lived in the district, and used these to organise and coordinate pastoral activities. The operations of these large scale

pastoral institutions can be compared with pastoralism during the collective period, in which control of land was combined with collective ownership of most of the livestock of the district.

Large-scale mobile systems of pastoral movement appear well suited to making optimum use of available forage resources, and can provide useful economies of scale. The forage available on much of the arid and semi-arid land is relatively low, yields being about 1-4 centners per hectare, and even on the better watered mountain pasture yields are not generally more than 5-8.[10] By moving livestock to different seasonal pastures pastoralists are able to make use of the different ecological and climatic conditions to get the best results from pastures in the different seasons. Available forage in the gobi, for example, does not fall as quickly or as far as those in better watered northerly pastures, which have higher yields in summer. Conditions are also highly variable from place to place, so that being able to move livestock in response to changing climatic conditions is a key method of avoiding livestock losses. Studies of East African pastoral systems with low and highly variable levels of rainfall in pastoral systems also suggest that high mobility and flexible access to wide areas of grazing is an important way of making the best use of these resources.[11] The collectives were also able to organise large-scale haymaking and district-wide delivery services which provided much-needed fodder in late winter and early spring. They were able to stockpile central reserves of fodder in case of particularly harsh winters when livestock would need extra forage.

When the collectives were dissolved in the early 1990s, many of the large-scale movements and economies of scale that had been retained by the collectives have declined, and pastoralism has become increasingly atomised. This has caused a whole series of problems for herding families, many of whom now have difficulty marketing their produce, and who no longer have the support of hay or transportation that the collectives provided. The long movements that the collectives organised were supported by mechanised transport. Without this service and managerial imperative pastoral movement has declined. The lack of hay reserves and collective motor pools that could have been used to deliver fodder and move livestock is one of the principal reasons for the disastrous losses of livestock in this year's zud (harsh winter) in which an estimated 1.6 million animals have died at the time of writing.

The importance of large herd-owning institutions in the past is an interesting element in the development of a model for the current rural economies of the region. If a system of wide pastoral movement is seen as a long-standing method of pastoral intensification, often supported by a large-scale institution, it bears comparison with the other strategy for economic intensification that has been applied to the region - that of agro-industrial sedentarisation, which has also been applied through large institutions, the collective and state farms. In a highly mobile pastoral system primary produce (natural) is made available to animals by frequently moving them. In the sedentary model conditions are created so as to maximise the amount of fodder grown, which is then harvested and fed to relatively static animals. Both strategies require an intensification of labour, which can be addressed through the application of mechanisation.

It is important to note that state and collective farms have been able to support both forms of intensification through mechanisation. Thus in Mongun-Taiga in Tuva in the late 1980s, where there was a highly mobile system of pastoralism, all herders' migrations were carried out by trucks supplied

by the farm, and herders often used motorcycles to get to pastures and even for certain types of herding. It is not that we would recommend the last-mentioned practice, but the point is that mechanisation (water-carrying trucks, mobile shops, livestock transport, hay-cutters, etc.) can be used to support the distinctive Inner Asian 'tradition' of pastoral intensification through mobility. In present economic circumstances this would require a definite policy decision from local authorities to provide petrol, vehicles and repair-shops strategically and in the public interest. In Inner Mongolia at present the herders are no strangers to the idea that mechanisation reduces labour, and around one third of herders in our studies had mini-tractors used for personal transport or minor haulage. But the high price and unavailability of petrol and repair facilities, and the uneven distribution of tractors, mean that they are not used effectively to sustain a mobile system of pastoralism in the districts as a whole. In Hargant (Hulun Buir, Inner Mongolia), for example, certain distant pastures are under-used. The message is that district-wide management, possibly underpinned by specific herding institutions, could reconstitute intensified and market-oriented production on a mobile model.

Conclusion

The principal mechanisms of both cultural and pastoral-economic change in the steppelands of Inner Asia are the institutional forms introduced to the region in the last seventy years. State-run organisations created entirely new patterns of land-use, power structures, lifestyles, educational environments and aspirations. The livestock economy was organised by means of large collectivist farms that divided herders into specialist brigades. These institutional forms were perforce adapted to meet local conditions, but were originally products of Chinese and Russian political cultures. It was in Mongolia and Tuva (Russia) that these institutions were allowed to organise practical herding in ways that most closely resembled earlier pre-socialist pastoral organisation. The collectives in these regions made fewest changes to earlier patterns of land-use (the relation between use of land for pasture, hay, fodder crops, crops for human consumption, etc.), and they kept, or even enhanced, pastoral mobility for certain types of herds. Mongolia and Tuva are regions where good environmental conditions have been maintained. The districts in China which have retained large state farms with a similar specialised organisation also have relatively good pasture conditions. The issues here are complex, but, in sum, these findings challenge the widespread western assumption that collective-type farms are necessarily culturally and environmentally destructive. Our research suggests that they should continue to be part of policies for management of the livestock economy in combination with other forms of organisation.

In Mongolia in the past, in both the pre-revolutionary and the socialist period long migrations were used as a strategy of intensification of production. This technique was used by large herd-owners and institutions to produce for non-subsistence exchange, see Humphrey and Sneath (1999). This argument challenges the stereotypical view that seasonal migration is something of a 'primitive survival technique,' and that the only way to intensify pastoral production is to reduce mobility.

The case-studies also suggest that pasture degradation is associated with the loss of mobility in pastoral systems. In both pre-revolutionary and collective periods it seems that pastoral movement was often facilitated by large herd-owning institutions, and one of the effects of privatising livestock

has been to reduce the amount of movement undertaken by many pastoral households. The more mobile of the case-study sites were those in mountainous regions, and those (in Tuva and Mongolia) where a state or collective farm continued to organise and support pastoral movement. Very low mobility and the cultivation of fodder crops with the use of heavy machinery in Buryatian regions is associated with severe problems of pasture degradation. Privatisation in China, also accompanied by reduction of movement, again seems to be correlated with a decline in pasture quality in many areas. These findings challenge the idea that sustainable pastoralism in Inner Asian steppe regions can be achieved without retaining mobility.

Appendix A :- Research participants in the MacArthur ECCIA Project

Dr. C. Humphrey, Dr. D. Sneath, T. Brain, M. Chopping, Professor Erdeny, Professor Chen Shan, Dr. B. Erdenebaatar, B. Telenged, B. Batbuyan, S. Lhagva, D. Shombodon, S. Tserenchimed, S. Tserendash, A. Hurelbaatar, Qi Xiao-Hong, Dr. Naran Bilik, A. Hasbagan, Prof. B. Erdenijab, Zhang Mei, Dr. Tsui Yen-Hu, B.P. Tseren, Dr. Cui Da-fang, Dr. Dilimulat Omar, Dr. Balzhan Zhimbiev, Dr. Bair Gomboev, Dr. Ts. B. Budaeva, Dr. G. V. Manzanova, Dr. A. K. Tulokhonov, Dr. N. L.Zhukovskaya, Dr. Marina Mongush, Dr. S. S. Kurbatskaya, Mergen Mongush, Dr. L. Kh. Tas-Ool, Professor D. Bazargur, Professor Chen Zuozhong.

Appendix B:- Participating Institutions

The University of Cambridge; The Baikal Institute for the Rational Use of Nature, Russian Academy of Sciences, and the International Centre of Social Ecology of the Baikal Region; East Siberian Technological Institute; Inner Mongolia Normal University; Mongolian Institute of Geography & Geocryology; Mongolian Research Institute of Animal Husbandry; Tuvan Institute of Language, Literature and History, Tuvan Academy of Sciences; Xinjiang Academy of Animal Husbandry Science; Xinjiang Normal University.

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Note:

1 The complexity of the concept of carrying capacity in relation to Inner Asian pastoralism is discussed in more detail in our Interim Report, 1992.

2 The problems include the variability of vegetation yields from year to year, the problems of not taking into account local pastoral practices (e.g. grazing behaviour of different species, succession of flocks on a given pasture), the vegetation re-growth factor, the problem of mathematical extrapolation in a highly varied landscape, the ecological characteristics of long cycles, and possible assumptions of a livestock-vegetation equilibria where no such equilibria may exist.

3 In Mongolia the data was collected at the level of the sum; in Inner Mongolia the banner (hoshuu), and in Buryatia, Chita and Tuva the raion statistics were used.

4 A study of the NOAA AVHRR scenes for 1986 - 88 seems to show a noticeably lower amount of vegetation in the Jirim region of Inner Mongolia than one might expect from precipitation levels. This may well reflect the intensive use of the land in these localities. The percentage of land used for agriculture is largest in the city districts of Huhhot and Baotou, where they reach 26% and 22% respectively. Of the other Leages and prefectures the percentage of land used for agriculture is as follows:- Wuhai - 2% cropland, 87% pasture; Chifeng - 9% cropland, 63% pasture; Hulun Buir - 2% cropland, 46% pasture; Hinggan - 7% cropland, 51% pasture; Jirim - 12% cropland, 76% pasture; Shilingol - 1% cropland, 96% pasture; Ulaanchab - 15% cropland, 68% pasture; Ihe Jao - 2% cropland, 63% pasture; Bayannur - 5% cropland, 81% pasture; and Alashan - less than 1% cropland and 68% pasture. The IMAR total is 4 % cropland and 67% pasture. See Longworth & Williamson, 1993 p.81.

5 Kurbatskaya's report (1993) for the MacArthur ECCIA Project gives data on pasture degradation in Tuva as a whole, indicating that our case-study site at Solchur was typical of rural regions without arable agriculture.

6 There are 53,000 square Km cultivated, and 880,000 square Km classified as grassland - 74.4% of the total area of IMAR, according to Inner Mongolia Association of Foreign Cultural Exchange publications. However, Yong Shipeng & Cui Haiting give the total area of grassland as 791,529 Km sq (only 75.58% of which is utilisable for grazing).

7 See Yong Shipeng & Cui Haiting IN Li Bo et al (eds) p. 94 They argue that of the total area of grassland (791,529 Km sq) only 75.58% is utilisable for grazing. They calculate the yearly forage yield as 91,286,657 tons. If stalks are also taken into account the total yearly forage is estimated as 107,666,000 tons. Based on this total yield they calculate a 'carrying capacity' in stock of 70,663,000 units in sheep equivalent SSUs. The 1986 total figure was 69,373,600 SSUs.

8 See Orie Loucks and Wu Jianguo, 1992, p. 71 of Grassland and Grassland Sciences in Northern China.

9 Levels of precipitation varied between the case-study sites, but we found them still broadly comparable. Most of the case-study sites included areas that fell into different bands of average annual precipitation. However the mid-points for these districts were all in the range 200-350mm .

10 Average pasture yeilds are about 1-3 centners per hectare in gobi regions, 3-4 in steppe regions, and 5-8 in mountain pastures. See Purev in FAO 1990:43.

11 See R. Behnke, & I. Scoones, 1993.