Land Tenure, climate change and livestock mobility in Central and Southern Asian Grasslands

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Introduction

Grasslands covering 20 to 40% (26.8 to 56 million km^2) of the entire land surface on the earth are the widespread vegetation type, and represent a major source for agricultural production (Suttie *et al*., 2005). In particular, Central and South Asia have vast areas of grasslands that are essential for livestock production, rural livelihoods and ecosystem services (Suttie, 2003). The services that grasslands provide are often overlooked although they have becoming increasingly important due to increasing human and livestock populations. Some of the services they provide present economic value that is often underestimated. Grasslands provide a number of services such as; forage, wildlife, timber, clean water, seed dispersal, mitigation for droughts and floods, cycling and moving nutrients, detoxifying and decomposing waste, controlling agricultural pests, maintaining biodiversity, generating and preserving soils and renewing their fertility, contributing to climate stability, regulating disease-carrying organisms, protecting soil from erosion, protecting watersheds and stream and river channels, pollinating crops and natural vegetation, providing aesthetic beauty, providing wildlife habitat, providing wetlands and playas, and provide recreational resources (USDA, 2013).

Grasslands are among the most important but widely neglected agro ecosystem components due to their inherent complexity of management in dry areas. The alarming exploitation of the grassland resources by humans and livestock cause the grassland ecosystems more vulnerable and less susceptible to the impacts of climate change that is becoming increasingly evident (Ates and Louhaichi 2012). Climate change, livestock mobility, and land tenure directly affect the current status of grasslands and the future potential that they hold. These aspects are important to understand and to address through monitoring and policy to assure the potential of this neglected agro ecosystem. Land tenure can secure access and investment in grasslands or can undermine it. Some countries are making progress to securing rights to grasslands and some countries are keeping them as open access commodities or allocating them to sedentary agriculture. The later unfortunately will only lead to further degradation and the former has positive potential. Livestock mobility patterns are changing due to the concentration of services in urban areas, the insecurity of tenure in some grasslands, the reservation of areas for conservation without grazing rights, the increasing fragmentation of some grasslands, or the potential to make more money in other areas. Increased mobility will become more important in a more variable climate due to the unpredictability of forage availability. Grasslands with variable vegetation availability will need to be grazed sustainably to increase biomass production and insure livelihoods. Climate change is likely to bring about even more erratic and unpredictable rainfall and more extreme weather conditions such as longer and more recurrent droughts. Where this happens, the delicate balance on which pastoral production systems depend

is undermined. The quality, quantity and spatial distribution of natural pastures are primarily governed by the amount and the distribution of rainfall. Predicted changes in rainfall patterns are bound to result in increasingly scarce, scattered and unpredictable grasslands. The number, distribution and productivity of permanent pastures and water points, which are extremely critical for livestock survival during the dry season, are bound to dwindle and becoming scarcer. Thus, it is important to understand the current and changing roles of climate, livestock mobility, and land tenure in grasslands as they can influence directly the ecosystem services that they provide and the livelihoods of pastoralists. This chapter provides an overview of the current status of mobility, climate change impacts, and land tenure regime in Central and South Asian grasslands and the future potential that they hold on the state of grasslands.

Current Effects of Climate Change

Warming of the drylands and predicted changes in precipitation carry implications for sustainable agriculture in the drylands over the next several decades. Overgrazing in grasslands is widely considered to be a major cause of desertification in arid pasture lands. Soils in drylands are inherently weak and are susceptible to both wind and water erosion. The reduction of plant matter and cover modifies the soil microclimate, which alters soil-water-plant relationships and exposes bare soil to erosion. Changes in climate variability will make addressing these problems more complicated. Changes in precipitation and increased evapotranspiration could have profound effects in some lakes and rivers (Sikakumar, 2007). The effects of climate change vary across the region. The greatest impact will be felt by the poor, who have the most limited access to water resources.

Earlier climate models predicted an increase in northern (north of 30° latitude) precipitation (Lioubimtseva and Cole, 2006) that may have significant effects in Central Asian countries. However from recent climate projections this has been called into question as most of the models used in the Fourth Assessment do not confirm these projections. The majority of the climate models project a slight decrease in precipitation, with a stronger decrease in the western and southwestern parts of the region and a very slight increase in the northern and eastern parts of Central Asia (~1 mm/day by 2050). However with spatial, inter-annual, and seasonal variability these projections are not reliable. Temperature changes are projected to increase by 3-5°C around 2080 and the warming will be accompanied by an increase in aridity (Lioubimtseva and Henebry, 2009). The rates of projected changes differ across seasons, with high temperature changes during the winter months. The expectation is for increasingly dry conditions with a slight increase in winter rainfall with decreases in spring and summer. The trend toward aridity will be more significant in the west from 70° to 72°E.

There may be significant changes in the regional water use patterns. Several multi-model assessments suggest that the volume of runoff from glaciers in Central Asia may increase three fold by 2050. Accelerated glacial melting can increase precipitation on the short run however flows level off as glaciers disappear. This could create the formation of glacial lakes, mudflows,

and avalanches. Temperatures in irrigated areas can be lower and precipitation can be higher than adjacent non-irrigated areas and the level of humidity can be hundreds of times higher (Lioubimtseva and Henebry, 2009). As a result, massive irrigation may have a stronger impact on the climatic system at the regional level than global climate change (Lioubimtseva and Cole, 2006).

In Mongolia and Inner Mongolia precipitation shows an increase in the winter months and gradients of slight decreases across the western dessert steppe with a slight increase in annual precipitation across the meadow steppe to the east. The current zones will move northward with high temperatures and increased aridity. The mountain taiga and forest steppe area are projected to be reduced and replaced by steppe vegetation. The meadow steppe might disappear and the typical steppe could be 55-75% of the present size. The dessert steppe could be only 80% of its present area and the warm temperate steppe could cover 60-130% of its present area with warmer temperatures. The net primary productivity in most areas is likely to decrease with increasing temperatures and decreasing precipitation. This will also create shortages in water resources. Runoff into major rivers will likely decrease, causing a reduction in lake water levels or the elimination of some lakes. While increases in precipitation will occur in some areas, increases in temperature will increase the evaporation of soil moisture. More frequent and prolonged droughts could reduce the availability of supplemental feed for livestock during drought periods. Non-native species may increase due to low productivity although the areas has been resistant to non-native species in general (Angerer *et al.*, 2008).

India will receive between 2.3 and 4.8°C rise in temperature over the whole country and an increase in precipitation. However it is not clear if the precipitation increase will occur across the whole country. Micro-scale modeling is not advanced enough to make reasonable projections at the local scale. Adverse consequences are expected in areas that will receive high temperatures as it can be associated with a decrease in rainfall, increased evapotranspiration or an increase in the incidence of droughts (Sirohi and Michaelowa, 2007). The possible reduction of forage is of grave concern as India has the largest livestock population in the world (FAOSTAT) and has poor availability of pasture and forage production. Only 3.4% of India is under permanent pasture and animals subsist on poor quality grasses available in the pasture and non-pasture lands or are stall fed mainly on crop residues (Sirohi and Michaelowa, 2007). The feed and fodder deficit in the country is already at 22% for dry fodder, 62% for green fodder, and 64% for concentrates (GOI, 2002). Higher temperatures can have adverse effects on dairy production of cross bred cattle and can increase some animal diseases. A likely consequence is a reduction in the total area where high yielding dairy cattle can be economically reared. A moderate increase in temperatures in high altitudes or winter months may decrease the maintenance requirements of animals. Any increase in the intensity and frequency of droughts in arid and semi-arid regions of India would greatly impact pastoral families as they have to migrate to arable areas to secure livelihoods. Certain areas are more prone to migration than others. In the Banni grassland region of Gujarat state, 45% of pastoral families migrate with livestock during draught (Sirohi and Michaelowa, 2007). However across India, migration in response to drought was found in only 2% of households in areas of India and Bangladesh during 1983 and 1994-95 (Raleigh *et al.*,

2008). India is responding to the current situation as they have invested in understanding migratory patterns and improving feed markets.

Present Status of Land Tenure

Uncertainties of land tenure and land use rights cause pastoralists to feel insecure and as a result have little private incentive to assume stewardship responsibilities for protecting and conserving the local ecosystem resources (Jansky *et al.*, 2006). China has transitioned from an open access system to an individual household system on grasslands. However, it is argued that co-management and communal tenure may be more relevant in many part of China. It is argued that private, common, state, and open access tenure regimes can be complimented with co-management. Co-management is defined as "the sharing of responsibilities of natural resource management between national and local governments, civic organizations and local communities" (Banks, 2003).

In the Central Asian countries four of the five republics are considering the introduction of the pasture codes that have both individual and communal forms of tenure. Following the collapse of the Soviet Union individual allocation of land was primarily conducted for arable land except in Kyrgyzstan where separate provision for pasture were made early on but now has pasture as common property. There was a sharp drop in livestock numbers in Kazakhstan, Tajikistan, and Kyrgyzstan (Robinson *et al.*, 2012). The state continued to play an important role in Uzbekistan and Turkmenistan where livestock numbers were less affected but were still reduced (Robinson *et al.*, 2012; Gintzburger *et al.*, 2003). Private livestock distributions became characterized by a small number of households with large herds and a large number of households with a small number of animals. Since mid-1990s, traditional collective herding systems quickly became re-established amongst non-state livestock owners. However as livestock numbers recovered, attention turned to formal tenure of pasture. There is a concern that individualized modes of pasture may reduce livestock mobility particularly where the number of household livestock is low. With the introduction of current pasture codes, provisions of common pasture management are under debate in Uzbekistan, Tajikistan, Kazakhstan, and Turkmenistan (Robinson *et al.*, 2012).

In Pakistan the majority of the grasslands are owned by the government and under the control of the Forestry department. There is a very small fraction of grasslands that are private or communal. Grasslands cover 58% of the total land area and most are arid or semi-arid. The Forestry department has control over rangeland sites and some sites are being intensively managed where there is project funding. Although grasslands are declared as protected forests they are open to everyone for unrestricted grazing, cutting, and uprooting of plants. This is leading to a tragedy of the commons (Afzal *et al.*, 2008). Pakistan has undergone land reforms for arable crop land however this is missing in the grassland sector and the present situation is not sustainable.

In India the government has prioritized privatization of lands for sedentary agriculture and has allocated commons resources to nature conservation in many areas, reducing the area for

grazing. Lands that were originally used for grazing have been allowed for use from sedentary agriculture even when they are in arid and semi-arid environments and are uncultivable. Historically the management of the commons followed three distinct patterns; open access to all which eventually led to severe degradation, powerful landlords enforced management to assure that grasslands were not overexploited, and democratic village-level institutions that shared rights (Agarwal and Narain, 1989). The management of the commons can vary by state and locality. In the state of Rajasthan, the Rajasthan Tenancy Act of 1955 allowed the re-allotment of land based on long-term tenancy rights which allowed for those who had cultivated areas to obtain tenure. Farmers also pressured for irrigation expansion and the government has not prioritized the needs of sedentary agriculture over pastoralists in Rajasthan (Singh, 2012). This has caused for the Raika pastoralists to migrate longer distances and to rely on crop stubble as an important source of fodder (Louhaichi *et al.*, 2014).Pastures in Afghanistan are almost entirely owned by the state and managed under traditional informal agreements. However differences in opinions have emerged regarding these agreements in the post-conflict setting. As a result, agreements have been drafted amongst village leaders and elders regarding the legitimate users (Stanfield *et al.*, 2010). Development projects have focused on improving local agreements regarding pastoral use to reduce future potential conflict. These new agreements and the conflict in Afghanistan are changing pastoral mobility, but the extent is unknown.

Present Status of Livestock Mobility

It is commonly accepted that traditional grassland management systems based on livestock mobility enabled herders to engage in opportunistic grazing strategies that both increased average herd productivity and reduced riskiness of production resulting from climatic variability (Scoones, 1995). Mobility patterns vary according to the geographic region, institutional framework, and cultural groups (Kaufmann *et al.*, 2004). Across the region, the distance that pastoralists are traveling for forage is reducing. The contributing factors for this are many including migration to urban areas, diversification in income earnings, institutional laws, land encroachment, pasture degradation that reduces herd size, conflict, or the desire to stay around services in the city (Steinfeld *et al.*, 2006). Many authors agree that there have been significant changes in pastoral practices that follow the direction shown by the modernization paradigm (Brower and Johnston 2007; Goldstien and Beall 1991; Kreutzmann *et al.* 2011a, b; Montero *et al.*, 2009; Sheehy *et al.*, 2006). Recent fieldwork has produced evidence that pastoral practices are used in a flexible manner when the investment in migrating is expected to be profitable and when institutional obstacles can be overcome (Alden Wildey, 2004 and 2009; Inam-ur-Rahim and Amin Beg, 2011; Dangawal, 2009; Davies and Hatfield, 2007; Ehlers and Kreutzmann, 2000; Ferdinand, 2006; Finki, 2005; Kreutzmann, 2004; Kreutzmann and Shütte, 2011; Li and Huntsinger 2011; Manderscheid, 2001; Nüsser and Gerwin, 2008; Rao and Casimir, 2003; Tapper, 2008).

There are mobilization patterns that are characteristic to distinct parts of Central and South Asia. In the Himalayan zone, transhumance patterns are vertical, ascending to mountain pastures in summer and descending to warm areas in the foothills in the winter. Winter grazing is often close to arable and urban areas that provide sources of seasonal employment and the possibility to buy fodder in markets. There is a novel system in Western Bhutan where livestock are looked after by different groups of people at different seasons so that people can stay put. Three pasture

divisions have been reported in Bhutan and Nepal where yaks graze in winter on the summer pastures of cattle and hybrids, and the winter grazing areas of the cattle and hybrids is the summer pasture of buffaloes that graze lower down during winter. There has been a large decline in pastoral nomads however it is still the only occupation of a large Himalayan population. The Gaddis are a distinct pastoral tribe found in the state of Himachal Pradesh (Suttie, 2003). In the Himalayas there is a growing exclusion of valuable pastures through administrative acts of nature protection. The public and governments increasingly view pastoralism as an environmental threat (Sharma *et al.*, 2003).
In cold semi-arid Asia that lies south of the taiga which includes Buryatia, Tuva, Mongolia, Kyrgyzstan, Kazakhstan, and parts of China (Inner Mongolia, Northern Gansu, and Xinjiang); winter is a long period of feed scarcity, so the major goal in herding is to get stock fat enough in the summer and autumn to be able to survive until the spring. Over most of the area there is little interaction between herding and cropping. Deviating too far from mobile systems using hardy stock is full of risk as exotic breeds bring dependence on shelter and imported feed, which is not always economic and sustainable. The use of imported feed for winter may lead to overstocking and damage to pastoral vegetation. Most of the countries in this region report serious to very serious degradation of grazing lands. Mongolia is the least affected and has maintained herding mobility with hardy local breeds. Herding communities in China are generally Mongols, Kazakh, Kyrgyz, and Tibetans. The government implemented a "long-term contract grassland use system" in the last decade. Pastures were subdivided with long-term grazing rights given to individual families based on the number of family members. Families pay according to the contract to the government for use of the land. It has not been put into practice on all summer pastures due to their long distance from settlements and complex topography. In this same decade the degree of pasture degradation rose alarmingly. In Kyrgyzstan horses were traditionally the main livestock as they were best suited to long transhumance and foraging in deep snow, however sheep is now the main livestock due to market demand of their fine wool breeds. Pasture transhumance with three rotational divisions is still currently in practice with multispecies herds. Crop land is now under 49 year leases however pasture is almost all common grazing.

In Mongolia, *Otor*-travel to distant pastures has three major periods; spring *Otor* for grazing young grass, summer *Otor* for development of enough muscle and internal fat, and autumn *Otor* for consolidation of fatness. Emergency movement of large stock in a hard winter to other grazing reserves happens as well. Periodic *zud*, deep or frozen snow that keeps feed inaccessible, kills a large number of livestock and puts livestock numbers back in equilibrium. Mechanized wells and bores in many areas have not been maintained and have reused part of the grazing land that has not been recolonized by gazelles. After the fall of the Soviet control some social reorganization has occurred with a few families collaborating on herding tasks. However no larger associations that participate in overall land management have appeared. There is a lack of clear titles to grazing and haymaking rights, which has reduced mobility as herders may restrict movement to protect their winter camps.

In Pakistan the Swat valley has been a traditional winter grazing area for transhumant herders who graze alpine pastures of north-eastern Pakistan in the winter. The incorporation of this area into Pakistan and the privatization of much of the land that had previously been communal

grazing land has led to conflict and legal disputes that are still unsettled. Large afforestation programs from the mid-1980s created large plantation areas that are closed to grazing. Increased cultivation and plantation has caused blocks to traditional transhumance routes and now herders can only average 33 heads of small stock, when before it was one to two hundred. There has been a reduction in herding by 60 percent in the last twenty years (Suttie, 2003).

The *Raika* are a traditional pastoral group in Western India (Rajasthan state). They are known for long migration periods for nine months or longer due to the long dry season that leads to shortages in fodder. Scarce environmental resources in their original habitat force them to migrate with their animals on grazing expeditions. However their migration has often led to conflicts. They were traditionally a camel, sheep, and goat herding community. According to administrative reports from the years 1883-1884 grazing taxes were an important source of revenue for the state and pre-modern states maintained a large portion of pasture within the crown land to increase revenue (Singh, 2012). The *Raika* are now predominantly sheep breeders due to the wool market, however the extent of grazing land has not kept pace with the number of sheep, decreasing from 0.83 ha per animal in 1951 to 0.40 ha per animal in 1991 (Bharara and Mathur, 1999). The state has played a role in shaping migration patterns as it has favored cultivation over pasturage. The state has provided incentives and resources to farmers in villages and ignored pastoral needs. This has led to splits in the community and non-pastoral villagers have used environmental conservation to close off traditional grazing lands (Singh, 2012). The Rajasthan Tenancy Act of 1955 allowed the re-allotment of land based on long-term tenancy rights. Farmers then pressured the government to introduce irrigation which expanded agriculture further and has led the *Raika* to wander farther for longer periods. They normally migrate collectively, often for security reasons as they are often a source of tension among settled villagers in Gujarat, Haryana, Uttar Pradesh and other adjoining states. During one migration cycle a group of 15-20 members sell 150-180 livestock and lose 50-70 due to natural death (Singh, 2012). The state of Rajasthan has a large Raika population and produces two thirds of India's wool (Robbins, 1998). While not all *Raika* herders take long migrations, there are factors that are as associated with a greater likelihood to do so. *Raika* herders are more likely to migrate if they have larger flock sizes, if herders are younger, if the herder has a low educational level, if there are more adult members in the household, and if the herder has smaller land holdings. People from Jodhpur, Barmer, Pali, and Jalore generally migrate towards Uttar Praesh, Madhya Pradesh, and Haryana. Sometimes they have to cover 18-22 km from the migration route to reach water and travel and overall distance 1,550 km (Louhaichi *et al.*, 2014).

Camel owners in sand desserts are often migratory as they are small farmers, peasants, and landless pastoralists. Seasonal migrations are a primary feature of camel herders. Migrations follow fixed annual routes. Local farmers in highlands cultivate rain fed crops (mainly winter wheat) and migrate with camels and other livestock to the lowlands when the sowing is over. Camels are an important type of livestock throughout the drier areas of Central and South Asia. In China, Central and South and northern Asia the Bactrian camel is kept. From Afghanistan through the western Himalaya the Arabian camel is reared (Suttie, 2003). Camels are also important in Baluchistan and Afghanistan. Camel production practices vary among tribes. There are wandering camel herds that graze freely in the desert with an appointed duty person at

watering wells that provides water to the camels. There are also droved camel herds that are not left unattended and migrate to river banks or irrigated plains during pre-monsoon periods and are fed on unconventional resources and return to the dessert as soon as the monsoon commences. As the market for camel meet and milk is not commercialized camels are used as a source of traction power. Many sedentary subsistence agriculturalists will have a few camels and they will wander and stay around settlements. However, machinery and tractors have taken over almost 50% of camel draft power and transportation responsibility in agricultural operations in sandy desserts. As a result the camel production system may not sustain long and there will be even fewer mobile camel herds (Jasra and Mizra, 2004).

Potential Effects of Climate Change:

Payment for environmental services in grasslands is in its infancy but it is a potential option for better use and management of grasslands as well as a safety net to reduce vulnerability of rangeland inhabitants to climate change (Thomas, 2008). Measurements of net ecosystem carbon dioxide exchange (NEE) have indicated that grasslands can act as C sinks (Saliendra *et al.*, 2004). Sequestering soil carbon in well managed grasslands provides mitigation and adaptation benefits. Water losses are reduced from evaporation and run-off and the micro-environments that plants provide enhance biological diversity. Water quality is also improved from carbon restoration practices as well as restoration of land degradation that can enhance food security through increased productivity (Neely *et al.*, 2009). Currently governments often play a role through debt forgiveness, livestock feed subsidies, crop insurance programs, direct food aid, and relief employment programs (Thomas, 2008). However it has been argued that some of these interventions were counter-productive and have in fact worsened the situation. Feed subsidies can encourage overstocking and crop insurance can encourage cultivation of drought prone crops in high-risk areas (Hazel, 2004). Payment for environmental services however is now a possibility for Central Asia under Joint Implementation as economies in transition and the second window of the BioCarbon Fund (Thomas, 2008). As one stream of the BioCarbon fund is for rehabilitation of degraded lands, possible interventions could be to introduce shrub plantations by governments utilizing drought and saline tolerant fodder plants, use of water harvesting structures, controlled grazing, and exclusion of areas from grazing. Controlling access and tenure can be a problem in many areas however. Unclear tenure arrangements can inhibit investments as most grasslands are open access resources or government controlled (Thomas, 2008).

Identifying the beneficiaries and clarifying tenure are steps toward achieving payment for environmental service schemes in grasslands. Different benefits have beneficiaries at the local, national, and global scales. Compensation at the local level for local benefits have recently proven successful in some developing countries and may be more achievable and sustainable than some global markets (Sanchez-Azofeifa *et al.*, 2007; Alix-Garcia *et al.*, 2009). It is acknowledged that payment for environmental services will not be achievable in all grasslands and other long term solutions will also be needed.

While the effects of climate change may be varied across the region, management of non-climatic stressors can go a long way in building resilience to the effects of climate change

(Morton, 2007; Neely *et al.*, 2009). Developing countries are considered more vulnerable than developed countries, due to their low capacity to adapt (Thomas and Twyman, 2005). The key barriers that are identified by the Food and Agriculture Organization of the United Nations that will need to be addressed to overcome socio-political and economic barriers are;

> *land tenure, common property and privatization issues; competition from cropping including biofuels and other land uses which limit grazing patters and areas; lack of education and health services for mobile pastoralists; and policies that focus on reducing livestock numbers rather than grazing management* (Neely *et al.*, 2009).

Local adaptation strategies are important to understand so that adaptation and mitigation strategies as well as policy changes are appropriately designed. Under drought stress pastoralists engage in mobility, herd accumulation, diversifying into multispecies herds, using supplementary feed, paying for water, diversifying their livelihood away from pastoralism, and other intercommunity mechanisms (Morton, 2007). Improving adaption and resilience will be a key component to maintain livelihoods in low income areas that are subject to a changing climate. More research needs to be done to improve sound policy in adaption, mitigation, and improving resilience.

For better preparedness to the anticipated negative impacts of climate change, tools and modelling have been generated to inform policy makers to take appropriate actions (Ouled Belgacem and Louhaichi, 2013). Given the vast areas grasslands occupy across the region, the most cost effective approach is to rely on the use of GIS and remote sensing (Larson et al., 2013). From local to regional to global scales, remote sensing has facilitated significant advances in grassland mapping, monitoring and assessment. In recent times, satellite remote sensing has emerged as one of the powerful technologies supporting a generation rich with spatial information. This is due to the numerous characteristics that satellite data possess such as repetitiveness, synoptic view, data availability for remote areas and the digital format of data. Therefore, satellite remote sensing data and image processing have proven to be an effective technique for grassland monitoring and assessment providing valuable information to land managers and policy makers for proper management.

Potential of Land Tenure:

The voluntary guidelines of the Rio + 20 outcome document recommends "secure" land tenure. The international land coalition is concerned that this may blur the distinction between access and effective control over the long term. Not having effective control over land limits the confidence to invest. Also the language of "ownership" does not include individual and collective tenure arrangements that vary among countries. The International Land Coalition recommends that "the Post-2015 agenda should ensure that all women, men, indigenous and local communities have secure rights to land, property, and natural resources necessary for their livelihoods and well-being, and should devise a monitoring framework accordingly" (International Land Coalition, 2015). Grassland improvement can be increasingly difficult to maintain in open access systems. Collective or individual ownership that promotes land stewardship is in the interest of the long term sustainability of grasslands. However in some countries ownership is only achieved through sedentary agriculture that is not sustainable in dry

lands and can cause degradation. Such practices are not in the long term interest of food security. Providing pathways for collective or individual ownership of grasslands is needed where there is ownership insecurity and open access abuses that decrease the long term outlook of healthy grasslands.

Closed communal tenure could provide greater sustainability and a safe guard for small pastoralists under erratic rainfall regimes of semi-arid and arid grasslands. Sheep, goats, subsistence cattle, and camels are most often kept on grasslands and are tended by nomadic and semi-nomadic groups. Individual tenure may be more preferable for dairy operations. Pakistan has the 5th largest dairy production in the world and it is dominated by small producers who are increasingly located in urban and peri-urban areas (USAID, 2014). Dairy operations around urban settlements that have open access can cause degradation and a loss of capital for this industry over the long run. Closed communal and individual ownership both provide the exclusivity that open access systems are devoid of and promote a pathway for investing in the long term natural resource use of grasslands.

Potential of Mobility:

Clarity of grazing rights and leasing conservation areas for temporary grazing with monitoring would go a long way to improve the situation of migratory pastoralists. Pastoralists are changing their migratory paths due to the occurrence of new individual parcels, areas closed off for conservation, and conflict. Mobility is important in pastoral systems as it provides a safeguard against drought and subsequent animal losses. Grazing can maintain ecological states and rejuvenate vegetation if managed appropriately. While overgrazing can be problematic, monitoring and enforcement can reduce the occurrence of overgrazing and enable mobility. Digital technologies have evolved rapidly enabling the creation of systems that are less costly than transect monitoring.

The conservation status of grasslands can be determined with digital charting over time that includes species identification at distributed locations along set management regimes. This is difficult to achieve on a country level scale but can be used in areas that are more conservation sensitive to determine policy and enforcement. Greenness can be measured on a larger scale through satellite imagery however it does not take species composition into account which can change to unpalatable species with intensive grazing. Neither of these methods alone are particularly sufficient at measuring low lying grasses, but are still informative in the absence of monitoring. Digital methods can be performed rapidly in comparison to traditional cutting and transect techniques and are less destructive. As grasslands are often not valued in terms of their carbon contribution it is difficult to give a market value to mobilization and create incentives that would encourage sustainable usage. The inclusion of grasslands in carbon markets could go a long way to providing incentives to pastoralists who either depend on grassland to improve their management practices, or to make sedentary pastoralists more mobile, as well as to provide a revenue stream for monitoring costs.

Without the provision of mobile services such as education, water access, and veterinary care it is likely that mobile pastoralism will continue to decline. Mobile pastoralism is often a necessity

in arid areas where forage availability can be varied across large areas. However government subsidies for feed has only increased animal numbers and caused overgrazing (Hazel, 2004). Livestock insurance with limited stocking rates or coverage may provide a better safeguard to those who are dependent on pastoralism without causing ecological damage. Livestock insurance is new and future work is needed to make such schemes sustainable.

Conclusion:

Grassland degradation could indeed be a potentially serious threat to food security and pastoral/agro-pastoral livelihoods, particularly in heavily densely populated pockets of rural poverty. Further encroachment of cultivation into areas of fragile ecosystems or critical habitats for biodiversity conservation can lead to significant environmental deterioration.

Effective policies are essential to create land tenure stability that promote investment in natural resource management, secure mobility, and promote climate adaptation. Policies have to result in strategies that insure rehabilitation of degraded lands and sustainable use under changing climate and land use. Open access rangelands do not promote the long term sustainability of rangelands and make sustainable rehabilitation and payment for environmental services impossible. Pastures that are subject to open access tenure arrangements need to have defined collective or individual rights. Ideally, communities organize to generate internal sanctions that promote sustainable use. This fundamental reform is the foundation on which other efforts can be built and is necessary to create payment for environmental service schemes, secure mobility, and secure natural resource investment.

Grassland vegetation across Central and South Asia is changing at an unanticipated rate. This is due to the dynamic nature of grassland plant community responses to climate fluctuations (drought and wet conditions) and manmade disturbance (mainly overgrazing). To ensure that these lands are capable of providing sustainable products for future generations, their ecological condition should be monitored against specific standards. Thus, there is a need for short- and long-term monitoring of grasslands. This should be part of a long-term national strategy, implemented independently of short-term projects. Furthermore, with advances in technology, particularly the use of GIS and remote sensing, large areas can be mapped and monitored rapidly providing that appropriate technologies are used (Louhaichi, 2011).

Because changes in grassland ecosystems affect the livelihoods and development of rural communities, it is important that planners and policy makers be able to determine grassland condition and trend in relation to climatic and managerial factors at specific locations. With advances in geo-informatics vast areas can be mapped quickly, remote areas can be accessed and an assessment of the grassland condition and trend can achieved quickly at a relatively low cost (Louhaichi *et al*., 2012).

Policy decisions often are in need of more information to be applicable and realistic. Tracking mobility through the use of GPS collars can inform policy the adaptation strategies of pastoralists and what resources they are most dependent on (Gaur *et al.*, 2013). Such information allows for tenure arrangements and grazing leases to reflect current uses. Understanding movement can also help in identifying where there are large gaps that are being underutilized due to lack of

access to water, sedentary agriculture encroachment, lack of services, or conflict. Further research is needed on the carbon sequestration potential of rangelands under different management regimes. One of the difficulties in creating payment for conservation in rangelands is that often times the quantifiable impact of different management regimes is unknown and thus setting a price for compensation is difficult. Such information is attainable with investment in research in these areas. However governments are often reluctant to spare the costs of such research due to the low priority of these areas or an unclear understanding of the benefit of this information. There is a cost to ignoring grasslands and unfortunately complete rehabilitation of severely degraded lands that have been ignored is not always achievable.

Governments can improve the sustainability of grasslands by creating security of tenure through collective or individual ownership, monitoring mobility and pasture usage to inform policy, and building resiliency to climate change. Resiliency to climate change can be done by promoting mobility through creating mobile veterinary and educational services and improving water access in remote pastures. Eliminating policy preferences towards sedentary agriculture in arid and semi-arid grasslands further promotes mobility and environmental sustainability. Allowing monitored grazing in conservation areas promotes mobility. Monitoring can be funded through grazing permits or leases. Policies that create incentives for the reduction of livestock numbers would increase resiliency over feed subsidies which increase animal numbers and overgrazing. Investment in livestock insurance schemes and creating local payment for environmental services where applicable can create incentives to reduce animal numbers if designed with caps on stocking rates. Nominal fees for grazing permits, water access, and insurance schemes can provide sustainable ways to pay for monitoring and water infrastructure repairs. Governments operate in limited funding environments and internal sustainable mechanisms to self-fund such policy changes should be replicated and explored.

Finally, it is urgent that all concerned stakeholders including researchers, development agencies and decision makers assess the types of grassland degradation issues that will be most critical and begin to take action now. The international community such as CGIAR can play a significant role in planning, supporting research and development of information systems, and analyzing experiences of various countries with different policy strategies.

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