Combating Pasture Degradation in Central Asia and the Caucasus—A Review of Approaches †

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1. Introduction

Degradation and unsustainable land use are recurring topics in pastoral systems. Grassland degradation incurs costs of USD 6.8 billion globally, only accounting for the loss of milk and meat production (Kwon et al. 2016). Le et al. (2016) found that, around the globe, 33% of grasslands, 25% of shrubland and 23% of sparse vegetation, which is often used for grazing, are degraded. Thus, globally, grasslands are assessed as the ecosystem type with the most widespread degradation. Improving rangeland management could make a crucial contribution to achieving Sustainable Development Goal (SDG) 15: "Life on Land" for dryland and mountain ecosystems. The topic is especially relevant for goal 15.3: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world" (UNDP 2020).

Land degradation is commonly understood as a reduction or loss in biological or economic productivity resulting from land uses or a combination of processes involving human activities (UNCCD 1994). Degradation typically is characterized by a persistent decrease in ecosystems to deliver ecosystem services (MEA 2005). Degradation involves reductions in vegetation cover, species changes, erosion or sedimentation, as well as disruptions in biogeochemical cycles in soils (Reynolds et al. 2007). Typically, degradation processes in drylands have multiple drivers producing diverse pathways depending on regions and time periods (Geist and Lambin 2004). While most processes are linear, non-linear, discontinuous processes may also occur (Suding and Hobbs 2009), making it difficult to formulate a clear definition of degradation that is applicable in all cases (Behnke and Mortimore 2016). In Central Asia, drivers of land degradation are mainly salinization, soil erosion and soil fertility depletion in croplands, whereas livestock-induced changes are most

frequent for rangelands (Mirzabaev et al. 2016). While the existence of degradation processes in Central Asian rangelands is uncontested, assessments of the extent and severity vary widely depending on the definition of degradation and methods used (Jamsranjav et al. 2018; S. Robinson 2016).

In Central Asia and the Caucasus region (CAC)[1] rangelands are the dominating land use and are thus relevant for achieving SDG 15.3 globally. The enormous importance of rangelands for land use in the CAC region countries is illustrated by their land cover: 56% of the total land area or 78% of the agricultural land is grassland (FAOSTAT 2020). This comprises 22% of the total grasslands worldwide (FAOSTAT 2020). Recent field data on grassland degradation in the CAC region are scarce compared to the Soviet period and often poorly documented, making it difficult to provide detailed and scientifically sound assessments on the current extent of degradation (S. Robinson 2016; Kerven et al. 2012). Based on global remote sensing data, Le et al. (2016) estimate that in Asia, 24% of grasslands, 33% of shrublands and 43% of sparse vegetation are degraded. In addition, in Central Asia rangeland, degradation is estimated to incur the highest costs compared to other forms of land degradation, such as desertification, deforestation and abandonment of croplands (Mirzabaev et al. 2016).

Different definitions for rangelands exist, but most of them emphasize that rangelands are dominated by grassy or shrubby vegetation and primarily support land uses associated with grazing animals (Lund 2007; Briske 2017). In the CAC region, rangelands are typically found in marginal areas, where arable farming is not possible due to cold or dry climate (Khazanov 1984). I define mobile pastoralism as a land use form using different livestock species, ranging from goats and sheep to horses, cattle, yak and camels, and involving nomadic or transhumant mobility between pasture sites (Dong 2016). Grazing areas in the CAC region can comprise steppes and semi-deserts, open areas in the forest zone as well as alpine and subalpine meadows in high mountain regions. Making use of marginal lands under extreme climatic conditions involves well-adapted livestock keeping practices, relatively large herds and special forms of human organization. This characterizes mobile pastoralist systems as closely interlinked social–ecological–technical systems (Scholz 1995).

A crucial aspect for sustainable rangeland management is the governance of rangeland access and use (Herrera et al. 2014a; Bedunah and Angerer 2012).

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[1] I define the CAC region as comprising the post-socialist countries in the South Caucasus (Georgia, Armenia, Azerbaijan) and in Central (Middle) Asia (Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan, Kazakhstan, Mongolia) and as a special case, Inner Mongolia, China.

Rangeland governance is a multi-faceted concept comprising regulations pertaining towards rangeland use and the resulting interaction of stakeholders at various levels. This encompasses international and government regulations in addition to the interactions of various stakeholders, community-based management as well as informal norms and practices of interaction between rangeland users (Herrera et al. 2014b). The governance regime has a huge impact on the practices of pastoralism, enabling, enhancing or precluding secure access to rangelands, cooperation among herders, mobility and flexibility in rangeland use. These practices decisively influence direct drivers of rangeland degradation, such as high stocking rates, lacking mobility and lacking maintenance of infrastructure (Mirzabaev et al. 2016). The mobile and flexible nature of pastoralism thus requires balancing the contradicting needs of security and flexibility of access and use, which is known as the "paradox of pastoral land tenure" (Fernandez-Gimenez 2002). Balancing these needs in land tenure is challenging, as it requires a suitable legal framework for rangeland governance complemented by informal norms.

Present-day pastoralism is also shaped by more recent political, social and economic influences. The CAC countries share a common history of socialist influence, trying to deeply transform pastoral organization, land access and management (Verdery 2004; see Shaumarov and Birner 2016 or Robinson and Milner-Gulland 2003 for examples). Large-scale, input-intensive systems of pastoralism with reduced mobility evolved until the 1980s. Starting in most states with the dissolution of the Soviet Union in 1990, the countries are characterized by an ongoing process of post-socialist transition, comprising a deep change in political, social and economic organization and practices (Roland 2000, 2012; for China: reforms in the "post-reform period": Yu and Kasymov 2020) involving for mobile pastoralists a complete reorganization of pastoral groups, operation under the conditions of the market and the reorganization of land access and management. With formal independence or reforms in the political system, each country has begun its individual socio-political transition decisions and processes with regard to the general economy and pastoral land use. These policies are outcomes of complex negotiation and decision-making processes influenced by various stakeholders and interests (Cairney 2019; Kasymov et al. 2016). In pasture governance in many CAC countries, decisive roles are attributed to national level governments and international development organizations (Kasymov et al. 2016; Jaborov et al. 2017). Thus, starting from a similar history of socialist influence, transition policies and trajectories of the individual countries have varied in the last 30 years.

The fact that all CAC countries are characterized by a combination of ecological occurrence of temperate grasslands, heritages of mobile pastoralism, similar socialist influence and now diverging paths of policy making and economic development makes the region an interesting showcase for comparative studies on the impact of different policies in resource governance and sustainable land use. Policies range from a near privatization of pastures to approaches involving open and common access to pastures (Behnke 2008; S. Robinson 2020).

When taking a closer look (or sometimes clearly spelled out by stakeholders themselves or in analyses of policy processes), these policies are motivated by implicit paradigms of how rangelands should be managed and degradation can be avoided. These paradigms are also relevant for general discussions on resource and land governance beyond pastoralism. In this contribution, I review these paradigms and link them to policies of rangeland governance in the CAC countries. In addition, qualitative evaluations of socio-economic and ecological outcomes in relation to the governance regime as provided in the scientific literature are reviewed. Socio-economic outcomes assess the impact that the governance regime has on social organization, mobility and the management of herds. Ecological outcomes target the impact of the governance regime on rangeland conditions, i.e., differentiated use pressure and evidence for degradation.

The analysis is based on a narrative literature review (Galvan and Galvan 2017). The literature on governance approaches for the different CAC countries was acquired by keyword searches in the English-language scientific literature databases Web of Science and Google scholar, combining the keywords pasture, rangeland, mobile pastoralism, governance, land tenure, property rights and degradation with specific country or region names. Due to the scarcity of literature in this specific field, the literature obtained was complemented by snowball searches of citing and cited literature, expanding the literature body also to book articles and reports (Bailey 1978). Priority was given to the most recent and most detailed literature sources, ideally drawing on first-hand or empirical information from the specific countries.

In this contribution, the analysis starts with characterizing forms of pastoralism in CAC (Section 2) and depicting four paradigms of rangeland governance (Section 3). Rangeland governance approaches in the ten CAC countries are reviewed, their relation to the paradigms of rangeland governance is characterized and socio-economic and ecological outcomes are depicted (Section 4). Results are summarized and discussed (Section 5) and conclusions are drawn (Section 6).

2. Forms of Pastoralism in the CAC Region

Pastoralism occurs in many forms in the CAC region. I distinguish pastoralism according to the extent of household mobility into nomadic and transhumant forms, then according migration type into horizontal or vertical types and then characterize agropastoral forms. Forms of stationary livestock keeping and systems dominated solely by enclosed pasturing ("ranching") are excluded, although some traditional pastoral land uses might involve tendencies to stationary livestock keeping or ranching (e.g., in Kazakhstan: Kerven et al. 2016b). The different forms (nomadic vs. transhumant, or horizontal vs. vertical) should be rather seen as dimensions of a continuous space rather than clear-cut classifications (Dyson-Hudson and Dyson-Hudson 1980).

2.1. Nomadic and Transhumant Pastoralism

Nomadic pastoral groups are characterized by extensive mobility. This may comprise migration patterns with up to 1000 km per year, several single moves per year and the absence of a permanent home base for the pastoral household (Dong 2016). In the CAC region, e.g., pastoralists in the desert-steppe in Mongolia covered 1992 in up to 20 moves more than 200 km (Mearns 1993). Pre-socialist movement patterns of Kazakh nomads covered up to 700 km (Robinson and Milner-Gulland 2003). Movements mostly follow a seasonal pattern according to climate and vegetation differences in the region, but exact locations and move timings vary according to the weather conditions in each year. With this land use pattern, nomadic pastoralism is well adapted to variable rainfall patterns, especially under arid and semi-arid conditions, making use of scarce forage resources variable in space and time (Mearns 1993). Nomadic movements in the CAC region are also motivated by low temperatures and snowfall (e.g., Robinson and Milner-Gulland 2003; Mearns 1993). Housing constructions adapted to mobility emerged as yurts or tents in traditional forms (Dong 2016).

Nomadic pastoralism was historically (and partly still is) widespread in Central Asia, especially in Mongolia (Fernandez-Gimenez 1999), China (Inner Mongolia) and high elevations of Tibet (Thwaites et al. 1998; Manderscheid 2001), but also in Kazakhstan (Robinson and Milner-Gulland 2003).

The integration of nomadic pastoral peoples into state structures was historically difficult, having often led to a suppression of mobility and forced settlement (Amitai and Biran 2005). In modern times, there is a tendency towards shorter migration and the transformation of nomadic to transhumant pastoralism (see below) due political changes and the amenities offered by permanent housing locations

(such as access to infrastructure: running water, permanent electricity and education; Ehlers and Kreutzmann (2000); Mearns (1993)).

In transhumant pastoralism, the livestock-keeping household has a permanent home base and conducts seasonal migrations to other rather fixed pasture locations (Dong 2016). The pastoral household spends at least one season in the permanent home. In other seasons, the whole household or parts of it live on other pastures. Collective herding practices enable that only a single member of the household or only the livestock under care of another herder is on migration, while the household resides in the permanent home.

More specific classifications of transhumant pastoralism are set up according to the location of the permanent home base in the migration pattern or the number and persons involved in the moves (Beuermann 1967; Ehlers and Kreutzmann 2000).

2.2. Vertical, Horizontal and Radial Mobility

Horizontal or vertical mobility can occur in principle with nomadic and transhumant pastoralism. Horizontal migration occurs along climatic zones more or less in a similar elevation and characterized by more southern or northern locations. In the CAC region, horizontal migration occurs mainly in Mongolia and Kazakhstan (Robinson and Milner-Gulland 2003; Fernandez-Gimenez 1999). As horizontal migration involves longer distances, it occurs more frequently with nomadic pastoralism.

Vertical migration allows livestock to use different vegetation zones along an altitudinal gradient in mountain regions. Seasonal pastures are thus mainly characterized by a higher or lower elevation and (sometimes) exposition. While lower elevations are used during the winter months, subalpine and alpine pastures provide seasonal forage during summer. Due to the compact occurrence of vegetation zones along altitudinal gradients, migration distances are mainly shorter (a few to hundreds of kilometers). Vertical migration occurs more often with transhumant pastoralism (Dong 2016). In the CAC region, vertical migration systems occur virtually everywhere, where altitudinal differences exist: in the Caucasus as well as Altay and Tien Shan mountains (Stadelbauer 1984; Mestre 2019; Kreutzmann et al. 2011; Hauck et al. 2016).

A special form of mobility occurs when pastoralism is constrained by key resources, such as water points or wells. In this case, the movement pattern resembles a concentration of livestock and camps under strong resource constraints and a wider dispersion in the surroundings in less constrained seasons. In the CAC region, this mobility pattern occurs among pastoralists in Turkmenistan (Ferret 2014).

Mixed forms of migration may also exist, e.g., nomadic migration patterns in Mongolia.

2.3. Agropastoralism

In agropastoralism or combined mountain agriculture, pastoral groups combine mobile livestock keeping with arable farming, though they still receive a significant part of their income from livestock. While among pastoral groups sowing cereals in winter/spring locations is also conducted for improving the forage base of young or weak livestock (Suttie and Reynolds 2003), agropastoralism involves arable farming for harvesting crops directly for consumption or sale (Kerven et al. 2012).

Arable farming is often combined with transhumant pastoralism and vertical movements. Crops are grown at the permanent home base of the household or at intermediate steps during migration (Kerven et al. 2012; Ehlers and Kreutzmann 2000).

3. Paradigms of Rangeland Governance and Use

This section presents four paradigms of resource use and governance with relevance for rangelands. The paradigms include, in most cases, a characterization of rangelands and explanations for unsustainable use often termed "degradation" or "overstocking". A central part is recommendations for a rangeland property rights regime and how a sustainable management of rangelands can be achieved.

Central for the understanding of paradigms of rangeland governance is the discussion on equilibrium or non-equilibrium ecosystem dynamics in rangeland ecology. Before turning to the governance paradigms themselves, equilibrium and non-equilibrium understandings of rangeland ecology are presented.

The equilibrium model of rangeland ecology rests on the theory of plant succession. It assumes a climax state, which depends on the physical characteristics of a particular site (Clements 1916; Meiners et al. 2015). In grazed rangelands, plant succession is hindered, and instead a subclimax establishes according to the grazing intensity of herbivores (Todd and Hoffman 1999). Range management under equilibrium conditions is aimed at regulating the stocking rate of livestock in order to balance grazing pressure with forage supply in a limited area (Westoby et al. 1989). Thus, degradation occurs on the rangeland plot if the stocking rate is not adapted to the regeneration potential of the vegetation. Large-scale mobility of livestock is not taken into account. To date, this paradigm has been successfully applied in range management in Northern America and Australia, while development measures based on it led to devastating effects in African rangelands (Dijkman 1998).

Based on evidence from rangelands in the Sahel zone, the non-equilibrium paradigm was developed, which emphasizes the influence of abiotic factors on ecosystem states, particularly precipitation, and the limited capacity for internal regulation of those ecosystems (Behnke and Scoones 1993; Ellis and Swift 1988; DeAngelis and Waterhouse 1987). From the perspective of the non-equilibrium paradigm, the equilibrium paradigm of rangeland ecology was criticized mainly for lacking empirical evidence for the existence of equilibrial ecosystems and insufficient recognition of dynamic ecosystem processes (Briske et al. 2003). Instead of a close coupling of livestock and vegetation dynamics as suggested by the equilibrium model, under non-equilibrium conditions, ecosystem changes are driven by periodic and stochastic climatic events. Recurring droughts reduce livestock numbers to such an extent that livestock-density-dependent regulation mechanisms are of minor importance. Thus, under extreme non-equilibrium conditions, livestock-induced degradation processes are irrelevant. Instead, a flexible adjustment of stocking rates to the variable forage supply is recommended in order to improve rangeland management (Scoones 1994; Scoones 1992). The recommendations include temporal and spatial tracking of forage availability with flexible movements and possibilities for the sale and rebuying of livestock in drought events (Behnke and Kerven 1994; Ellis and Swift 1988; Illius et al. 1998).

The comparative testing of equilibrium and non-equilibrium models led to a synthesis of both approaches. Rangeland ecologists now predominantly assume a continuum between equilibrium and non-equilibrium characteristics, which depends on physical site conditions as well as spatial and temporal scales (Briske et al. 2003; Fernandez-Gimenez and Allen-Diaz 1999). Inappropriate rangeland use and degradation may even occur in non-equilibrium systems in key resource areas or following infrastructural developments, such as the provision of water points or external fodder (Illius and O'Connor 1999). The supply of these resources allows the exploitation of previously inaccessible forage, increases livestock numbers and thus can result in deteriorating rangeland conditions (Campbell et al. 2006).

3.1. Classical Economic Theory—Privatization (P1)

Classical economic theory does not distinguish rangelands from other natural resources. Thus, it implicitly draws on equilibrium rangeland ecology, assuming a predictable forage supply and aiming at the regulation of stocking rates. The explanation for unsustainable rangeland management is mainly found in Hardin's often cited "Tragedy of the Commons" (Hardin 1968).

According to Hardin (1968), under a common management, overstocking and degradation are nearly inevitable due to individual interests of herders. To ensure sustainable management of resources, privatization of common resources was recommended. Thus, for decades, private property was regarded as superior for the conservation of resources and agricultural development (Demsetz 1967).

This logic motivated policies of rangeland governance aiming at privatization, e.g., in the CAC region, the de facto privatization with long-term lease contracts under the "household responsibility system" in China (Banks 1997; Bauer 2005).

3.2. Legacy of the Soviet System: Strong State Control (P2)

Under Soviet rule, degradation was a side effect while aiming for maximum production goals. All land and production assets were owned by the state. Management plans on state and collective farms were set up by livestock production specialists (Verdery 2004; Shaumarov and Birner 2016) while local and traditional knowledge was regarded as old-fashioned. The provision of supplementary feed released production constraints, which would have normally limited livestock numbers and their impact on the pasture vegetation (Robinson and Milner-Gulland 2003; Robinson et al. 2003). After initial forced settlements of nomads failed, a system of reduced, regular mobility was allowed on collective and state farms (e.g., in Kazakhstan: Robinson and Milner-Gulland (2003), or in Azerbaijan: Baberowski (2003), Loomis (1989) on various Central Asian states).

For combating degradation, management was carried out according to a scientific-technical knowledge base building on expert studies since the 1920s (Shaumarov and Birner 2016). A fine-scaled monitoring system for agricultural land called "Bonitirovka" was set up, rating the quality and production potential of soils (Gavrilyuk 1974). A remedy for degradation problems caused by intensive use was seen in technical measures, such as winter feeding, rotational grazing, reseeding of pastures or inputs of mineral fertilizers (Liechti 2012; Loomis 1989; Shaumarov and Birner 2016).

3.3. Common Property Scholars: Common Management (P3)

Hardin and the Tragedy of the Commons paradigm were criticized from the 1980s for two major points: First, the narrative mixes common property regimes, where a well-defined user group jointly uses and manages a resource, and open access, where virtually everybody has access and rules are non-existent or not enforced. Second, the narrative refers to a situation without regulations in which individuals

follow solely their self-interest. Thus, the possibility of groups to craft and enforce rules is neglected (Feeny et al. 1990).

Common property scholars have been able to show convincingly that a "Tragedy of Open Access" is not inevitable. In contrast, human societies are able to manage resources collectively and sustainably over a long time (Ostrom 1990; Baland and Platteau 1996; Bromley 1992). However, research also showed that not all societies are able to ensure effective mid- and long-term solutions for collective action problems (Kellert et al. 2000). Rather, the stability of common property regimes and the prevention of resource depletion depend on certain factors, which are summarized in the design principles for common property institutions (Ostrom 1990) and their slight modifications (e.g., Agrawal 2001).

For pastures, the boom in common property resource management research induced interest in the "traditional" collective pasture management institutions of mobile pastoralists and a discussion on common property in rangelands in the CAC region (Behnke 2018; Li and Huntsinger 2011; Gongbuzeren and Li 2015). In countries with former socialist influence, a reluctance towards common management approaches is noted since the management by a group is seen as similar to the former collective management, which is associated with negative experiences (Mearns 1996). Although it is often argued that traditional resource management of pastoralists is a common property regime, Ostrom's design principle of "clearly defined boundaries" is violated in many traditional systems. Nevertheless, the mounting evidence for sustainable common property management led researchers and policy makers to recommend approaches of "community-based natural resource management" for pastures (Fernandez-Gimenez et al. 2012; Crewett 2012; Robinson et al. 2010; Ykhanbai et al. 2004).

3.4. New Rangeland Science: Open Property Regimes (P4)

The development of the non-equilibrium paradigm of new rangeland ecology led to a novel view on rangeland management in pastoral systems. In variable environments, herders try to adjust stocking rates to the variable forage supply by using tracking strategies and opportunistic livestock management. These management strategies are enhanced by a high degree of mobility, flexibility in spatial and temporal resource access as well as effective livestock marketing systems that allow the quick destocking and restocking of rangelands. Thus, the sustainable use of ecosystems as well as human welfare are threatened, if a flexible adjustment of stocking rates is hindered by institutional and economic factors (Scoones 1994, Behnke and Kerven 1994).

To facilitate sustainable use, pastoralist rangeland access regimes under this paradigm should be flexible and overlapping to adapt to the unpredictable characteristics of the resource (Goodhue and McCarthy 2000; Scoones 1994). For the CAC region, in addition to rainfall, especially cold temperatures and snowfall (*dzud*) were identified as factors crucially influencing rangeland productivity, accessibility and livestock numbers (Kerven 2004; Fernandez-Gimenez and Allen-Diaz 1999; Robinson and Milner-Gulland 2003; Li and Huntsinger 2011).

This focus on overlapping, open and flexible access rights is in strong contrast to the views held by common property scholars where clearly defined boundaries in a spatial and social sense are seen as crucial for the long-term stability of the common property regime (Ostrom 1990; Moritz et al. 2013). Instead, flexible access, open access or open property regimes are envisioned in which "there is open access to common-pool grazing resources but, and this is critical to note, open access does not mean the absence of rules; instead it refers to the right that every pastoralist has to common-pool grazing resources" (Moritz 2016, p. 689; see also L. Robinson 2019; Moritz et al. 2018).

4. Governance Approaches to Rangeland Management in CAC Countries

In this section, the governance of rangelands in ten CAC countries is reviewed. For each country, I (1) characterize the prevailing forms of pastoralism and (2) provide a short description of the major steps in rangeland policy in post-socialist transition, including the current policy framework for rangeland governance. As an evaluation, (3) the rangeland governance approaches are related to the four broad paradigms in rangeland governance described in Section 3, and (4) socio-economic and ecological outcomes as seen in the scientific literature are briefly characterized. Socio-economic outcomes assess the impact that the governance regime has on social organization, mobility and the management of herds. Ecological outcomes target the impact of the governance regime on rangeland condition, i.e., differentiated use pressure and evidence for degradation.

4.1. Georgia

(1) Forms of pastoralism: On the Georgian territory, steppe areas lying between Greater and Lesser Caucasus facilitate vertical pastoral movements along a steep altitudinal gradient. Stationary and mobile livestock keeping overlaps partly in agropastoral livelihoods (Stadelbauer 1984).

(2) Governance approach: The post-socialist land governance reform process in Georgia started with the dissolution of state and collective farms in 1992. A far-reaching

privatization of agricultural land was initiated, which also allowed the lease of pasture land from 1996. Of the 1.8 million ha of pasture, in 2002, 83,300 ha was privatized, 600,000 leased and 940,600 ha remained in state ownership (Tsomaia et al. 2003).

Between 2005 and 2008, pasture land was planned to be transferred to municipal ownership. However, this process was stopped, and up to 1 million ha pasture land is now under jurisdiction of the Ministry of Economy and Sustainable Development without further provisions for its management and use (as of June 2020). While officially pastures cannot even be leased out, there are exceptions for several municipalities as well as short-term oral use agreements (Gvaramia 2013). In consequence, there is a mixture of ownership structures with private owners (15–25%), municipality ownership (2–5%), ownership by Agency of Protected Areas (APA; 2%) and public property (70–80%) (Mansour and Phulariani 2016).

One major drawback for land privatization in Georgia was the late development of a public registry (starting only from 2004), which, to date, leads to many incomplete processes of land privatization (Gvaramia 2013).

(3) Relation to rangeland governance paradigms: As a general tendency, frequent changes in rangeland governance can be observed with a current intention to privatize rangelands (P1).

In publications on land governance, a variety of positions are articulated. In a quest for further privatization, e.g., a World Bank report (Welton et al. 2013, p. 77) explicitly draws on the Tragedy of the Commons to explain the low quality of pastures and overgrazing. Gvaramia (2013), which is a report of a local NGO, argues that "[i]t is also necessary to privatise animal transportation routes (if not privatised, serious management mechanisms need to be developed)". In contrast, in a report for Swiss Cooperation Office, Raaflaub and Dobry (2015) argue for a balanced approach allowing for cooperatives and user group-based management especially on village pastures.

(4) Reported outcomes: The frequent changes in overall rangeland governance and the management vacuum have created particular insecurity for land users since 2010. Evaluations of pasture quality produce mixed results due to the lack of comprehensive assessments (Mansour and Phulariani 2016). While some publications speak generally of overgrazing and low quality (Welton et al. 2013), others observe underuse and reforestation. A mix of overuse and reforestation processes is most likely, whereas overuse is likely to occur on easily accessible pasture sites and winter pasture areas (Gebhardt 2014).

4.2. Armenia

(1) Forms of pastoralism: Pastures comprise approximately 50% of the agricultural land in Armenia. The land-locked country has predominantly transhumant vertical migration systems along short distances partly combined with arable farming in agropastoral systems.

(2) Governance approach: While arable land was largely privatized based on shares in 1992, pastures remained in the hands of the state and were partly leased out. Between 2003 and 2005, management rights for remaining state land were handed over to local communities. While initially it was intended to give full ownership to local communities (including the right to sell and lease pasture), the government handed over finally only restricted rights in view of concerns about land concentration (Spoor 2012). In surveys, local farmers opposed sales of pastureland (Lerman and Mirzakhanian 2001). The government is working with development support on management schemes and tools for community-based pasture management (Christen 2020).

(3) Relation to rangeland governance paradigms: Armenia aimed at a pro-equality privatization strategy in land governance (Spoor 2012), while for pastures, after an initial search process with strong state control (P2) and intentions of privatization (P1), community-based solutions seem to be in progress (P3).

(4) Reported outcomes: Reports on the levels of pasture degradation or on socio-economic outcomes are scarce. A remote sensing study reports that more than 50% of Armenian pastures are degraded (Tepanosyan et al. 2017). A major issue seems to be the infestation with weeds and non-palatable plants mainly due to insufficient mobility and overgrazing pastures, especially around sheds and water sources (Christen 2020).

4.3. Azerbaijan

(1) Forms of pastoralism: High altitudinal differences on the slopes of the Greater and Lesser Caucasus with steppe and semi-desert lowlands in between allow for transhumant vertical migration systems along steep altitudinal gradients, but also vertical movements of shorter distances in agropastoral systems exist.

(2) Governance approach: In Azerbaijan, agricultural reforms started in 1996 with the privatization of livestock and machinery. Pasture land was not subject to privatization but remained in the hands of collective and state farms. Land access was reorganized in 2000, with the privatization of arable land, while pastures were not subject to privatization. While local village administrations (Belediyye) became responsible for administering village pastures, distant pastures and migration routes

are under district (rayon) administration. Distant pastures can be leased by mobile pastoralists for 25 years, and the individual leased plots have comparably fixed boundaries. By 2007/2008, all available pastures were leased out (Neudert et al. 2015). Contracts can now be obtained under an auction mechanism, while leasers have a primary option for renewal of contracts. Local village administrations have the option to lease parts of their village pastures to mobile pastoralists if these areas are not in use by local village livestock (Neudert et al. 2020).

(3) Relation to rangeland governance paradigms: In Azerbaijan, in post-socialist transition, pasture categories and usage patterns from Soviet and pre-Soviet times were continued or renewed. For distant pastures, the state aimed at an individualization of use with a strong position of the state (P2) but transfer of management rights resembling a near privatization (P1). Pastures in the vicinity of villages remained in common use under local administration (P3), whereas few provisions for effective community-based management were made.

(4) Reported outcomes: The use pressure on pastures in Azerbaijan is comparably high. During the distribution of lease contracts deviations from formal rules, e.g., use of private networks or bribing, occurred. However, during actual use, boundaries are well respected, while mobility is ensured due to the state management of migration routes, and informal cooperation and joint use agreements, which also enable mobility for owners with few livestock (Neudert 2015). Especially on village pastures, overuse is a frequent problem (Neudert et al. 2019).

4.4. Turkmenistan

(1) Forms of pastoralism: Desert and semi-desert ecosystems in Turkmenistan allow for semi-nomadic or transhumant pastoralism governed primarily by well water availability and salinity. The movement pattern is radial around wells, with the concentration of camps around wells in summer and dispersion in winter (Ferret 2014).

(2) Governance approach: In contrast to most other CAC countries, Turkmenistan has retained a comparably low level of privatization and higher state involvement. Reforms began in 1995 with the transformation of state and collective farms into farmer associations (Kerven 2003), while the farm assets remained nearly unchanged. The approach in the pastoral sector is termed "leasehold pastoralism" (Behnke et al. 2005). With lease contracts for state-owned livestock, herders manage the herd in return of a share of the offspring and products as long as production targets are met. Private livestock is allowed and is reported in increasing numbers (S. Robinson et al. 2017b). Rangelands and the associated water wells are state-owned and allocated to

the farmer associations, allowing for some degree of flexibility in pasture and well use. In addition, flexible decisions could be taken by herders with regard to mobility and access of other feed resources (Behnke et al. 2005; Behnke et al. 2016).

In 2015, a new pasture law was passed allowing now for community-based pasture access (S. Robinson et al. 2017b).

(3) Relation to rangeland governance paradigms: Turkmenistan combines a strong position of the state (P2) with regard to land and livestock ownership enabling effective decentralization and flexible decision making for herders. Thus, the rangeland governance resembles an open property regime (P4). With the increasing share of private livestock and a declining management role of the state, a change to towards stronger individual rights with the option of community-based pasture access is underway with the new pasture law of 2015 (P1, P3) (S. Robinson et al. 2017b). Whether the reformed system will be largely individualised or group based will largely depend on bylaws and implementation (Robinson et al. 2018).

(4) Reported outcomes: Based on extensive field research at the rim of the Karakum desert, Behnke et al. (2016, p. 117) conclude that the system is "insufficient to halt the growth in absolute levels of grazing pressure or the loss of vegetation cover around large water points, but they do retard the rate at which larger settlements grow in size, and are sufficient to maintain constant levels of animal performance", thus resembling an ideal free distribution of livestock. However, reports on pasture conditions are contradictory: S. Robinson et al. (2017b, p. 237) report that overgrazing is "perceived to be a serious problem" alongside increasing grazing pressure near settlements. In contrast, satellite imagery studies report a medium to good pasture condition without clear tendencies along transects to wells (Gintzburger et al. 2009), or pasture vegetation rehabilitation around settlements occurring alongside degradation due to the development of biogenic crusts in remote areas (Kaplan et al. 2014).

4.5. Kazakhstan

(1) Forms of pastoralism: The Kazakh territory historically hosted large scale pastoralist movements, which began to decline in length and scope in the 18th century with the establishment of the Russian empire. In the socialist period, collective and state farms with shorter migration cycles and the provision of winter fodder were established (Alimaev and Behnke 2008, Robinson and Milner-Gulland 2003).

(2) Governance approach: In the mid-1990s, the livestock holdings declined dramatically (Robinson and Milner-Gulland 2003), and in 1995, it became possible to lease agricultural land, arable land and pastures, for 99 and later 49 years. While the lease system worked well for arable land, the demand for pastures remained low

and, de facto use without lease contracts was common, as lease processes were complicated and costly. Movements ceased nearly completely particularly in desert regions, while grazing with few livestock took place around settlements (Alimaev and Behnke 2008), and short distance migrations in mountain regions were reestablished comparably quickly (Ferret 2018).

An amendment of the Land Code in 2003 allowed the acquisition of rangelands by purchase in addition to the leasing option, except lands in shared use. Pastures around settlements remain in the hands of local communities and are considered as "commons", as reported by a World Bank document (Schillhorn van Veen et al. 2004). Thus, different access options are available for herders, ranging from private (primarily winter pastures) to communal and open access options (Kerven et al. 2016a, 2016b). A reform of the pasture law in 2017 now formally allows for the creation of voluntary associations of pasture users (S. Robinson et al. 2017b).

A reform of the Land Code in 2016 attempted deeper changes in land access governance with an abolishment of all lease options, effectively allowing only for purchase of land. Following public protests, the reform and all land privatisation and sales were put under a moratorium until 2021 (S. Robinson 2020).

(3) Relation to rangeland governance paradigms: Kazakhstan's land governance initially made no difference between rangelands and arable lands with providing lease options (P2), but differentiated its management regime into several options for different rangeland resources involving privatization, lease and common management broadly dependent on the resource characteristics (P1–3).

(4) Reported outcomes: Several sources note a strong decline in mobility, inducing severe overgrazing around settlements and underuse in remote areas (Kerven et al. 2006). Mobility is re-established predominantly by herders owning greater numbers of livestock and crucial assets, such as trucks and access to wells (Kerven et al. 2006, 2016a; Milner-Gulland et al. 2006). Outcomes of the reforms of the pasture law in 2017 and the Land Code reform in 2016 cannot be assessed, yet.

4.6. Uzbekistan

(1) Forms of pastoralism: Uzbekistan has a history of nomadic pastoralism, while in recent years, desert and semi-desert areas have been used in horizontal transhumant migration systems. In mountain areas, vertical migration systems also exist, although vertical migration has minor importance at the national level (Kerven et al. 1996).

(2) Governance approach: With reforms of farm structures in 1992 and a new Land Code in 1998, the government took a restrictive approach to transition allowing no private ownership to land (Lerman 2008). All land remained state property;

former state and collective farms in arid regions were transformed into agricultural cooperatives in dry areas (*shirkats*, Zanca 2000; Shaumarov and Birner 2016), whereas district governments were mostly responsible for rangelands in semi-arid areas. Pastures can be leased for 49 years by entrepreneurs or agricultural cooperatives, who can allow others to use the land. In fact, land under the jurisdiction of districts is open access (Christmann et al. 2015). As households (*dekhan farms*) are de facto excluded from land lease (Christmann et al. 2015) but hold the greatest share of livestock (S. Robinson 2020), access to grazing land is mostly gained informally (Shaumarov and Birner 2016).

As reported on the website of the International land coalition, in 2019, a new law on pasture management became effective, enabling the development of pasture user associations and measures for improved pasture management and restoration (Yuldashev and Ykhanbai 2019).

(3) Relation to rangeland governance paradigms: Uzbekistan followed a restrictive policy with regard to land ownership intended to avoid land speculation and to preserve pastures as a national source of wealth (P2) (Lerman 2008), but de facto providing no regulation adapted to the resource characteristics of rangelands. The new law issued in 2019 proposed "pasture user associations", a community-based approach to pasture management (P3) (Christmann et al. 2015).

(4) Reported outcomes: Lerman (2008) describes a slight growth in cattle numbers, while abandoned pasture land and a reduction in fodder crops are also noted, implying a higher pressure on some pasture areas. Pasture land seems to be abandoned due to the lacking maintenance of water infrastructure and degradation (Shaumarov and Birner 2013). Christmann et al. (2015) terms the present-day use "unsustainable" and sees the system as being characterized by "the Tragedy of the Commons" and "free riding", as no fees for pasturing and shrub harvesting are collected, and uncontrolled grazing without shepherds occurs. Their work aimed at the establishment of pasture user groups and pasture regeneration.

4.7. Kyrgyzstan

(1) Forms of pastoralism: Rangelands cover approximately 80% of the land resources in Kyrgyzstan. The mountainous terrain allows for transhumant vertical migration and agropastoral systems of short and medium distances (Shirasaka et al. 2016).

(2) Governance approach: In 1998, Kyrgyzstan adopted far-reaching reforms of the agricultural sector, involving a far-reaching privatization of land and livestock. Pastures remained under state control with lease options (Dörre 2012; Undeland 2005). In 2009, Kyrgyzstan adopted as the first state in the Central Asian region

a community-based management approach. After disappointing results with the lease approach in pasture management, the community-based approach was jointly developed by government officials and international donor organizations (Kasymov et al. 2016). Control over pastures was handed from municipalities to pasture user committees, setting up management plans and granting access rights (Kasymov et al. 2016; Dorre 2015). Participatory monitoring approaches are being tested as a basis for informed decisions on pasture management and degradation prevention (Kirch et al. 2016).

(3) Relation to rangeland governance paradigms: From an early approach of strong state control (P2) which was incompletely implemented (Kasymov et al. 2016), Kyrgyzstan soon moved to an adoption of a community-based management approach (P3) with local control over pastures and explicit provisions for user participation.

(4) Reported outcomes: During the initial period of transition, a marked decline in pastoral mobility and overuse of pastures in the vicinity of villages was noted (Farrington 2005). While after 2009, in many places, control over pastures by pasture user committees was established, authors report a gap between intentions and implementation (Kasymov et al. 2016), elite capture (Crewett 2015; Dorre 2015) and lacking acceptance by local pasture users (Shigaeva et al. 2016). However, Kasymov and Thiel (2019) see a declining asymmetry in bargaining power, leading potentially to more equitable outcomes in the future. The community-based approach is evaluated as an improvement compared to the previous lease system; however, it still has shortcomings with regard to facilitating mobility and flexible movements (Mestre 2019; Crewett 2012) and to matching pasture availability with demand (Shirasaka et al. 2016).

4.8. Tajikistan

(1) Forms of pastoralism: Located in the high-mountain region of Central Asia with more than 80% of the country being pasture lands, Tajikistan's environment supports transhumant vertical movements in agropastoral systems (Robinson and Whitton 2010).

(2) Governance approach: Before 2013, there was no special legislation in Tajikistan applying to pasture land, but general land access options were applicable to pastures, including the option for long-term inheritable rights (Halimova 2012). However, no effective governance was established, leaving the pastures de facto open access. A reform in 2013 followed the Kyrgyz model of community-based governance: pastures are owned by the state, while management is delegated to commissions at the district level. Access can be community-based by user associations or individually

based on leases (Jaborov et al. 2017). This leads to a legal coexistence of private and common access options (S. Robinson et al. 2017b).

(3) Relation to rangeland paradigms: Tajikistan first aimed at a strategy of strong state control (P2) while also providing options for the privatization of pastures, which were not implemented (P1). The reform in 2013 generally followed the community-based approach in Kyrgyzstan (P3), but the approach was only adopted incompletely. The weak commitment of the Tajik government and gaps in the legislative framework resulted in a very slow progress of implementation (Jaborov et al. 2017).

(4) Reported outcomes: Lacking mobility and herd sizes led to initially low interest in obtaining private or lease rights for pastures. Declining mobility resulted in an overuse of pastures in the vicinity of villages, whereas remote pastures were virtually abandoned (Robinson and Whitton 2010). The implementation of the 2013 pasture law is uneven, with the creation of pasture user unions and pasture management plans heavily dependent on NGO intervention (Jaborov et al. 2017). In parallel, granting long-term inheritable (de facto private) rights of large plots to wealthy individuals seems to take place, creating a growing number of landless rural households and social tensions (Halimova 2012).

4.9. Mongolia

(1) Forms of pastoralism: The vast steppe and desert areas in Mongolia have hosted nomadic cultures for millennia. Nomadic pastoralism with a combination of vertical and horizontal movements is still common (Fernández-Giménez et al. 2018; Mearns 1993), although there is trend for reduced migration distances and less moves (Chen et al. 2018).

(2) Governance approach: Despite early policy advice to privatize pastures (Murphy 2011), Mongolia maintained state ownership of all pasture land (Fernandez-Gimenez and Batbuyan 2004). A major reform implemented in 1994 allowed the private lease of winter and spring camp sites. Thus, land access is mainly governed through campsite access rather than by rights pertaining to land per se. Local and regional authorities were made responsible for managing grazing pressure and seasonal mobility. Responding to unclear and contradictory issues of the 1994 law, in 2002, an amendment to the pasture law was issued, allowing group ownership of winter and spring camp sites and a consequent local responsibility for grazing management (Fernandez-Gimenez and Batbuyan 2004). Many authors note a strong complement and interpretation of the legal provisions with customary rules (Upton 2009), e.g., pertaining to reserve pastures and irregular long-distance migration in the

case of hazardous weather conditions (Murphy 2011). Development organizations promote actively community-based natural resource management to complement local government responsibilities for grazing management (Addison et al. 2013; Ulambayar et al. 2017). Since 2007, an amendment of the pasture law has been discussed with a central purpose of making provisions for the transfer of ownership and management rights of pasture areas to pasture user groups (Fernandez-Gimenez et al. 2008; Hannam 2014). The law is still in parliamentary discussion (Undargaa 2017).

(3) Relation to rangeland paradigms: Pasture access in Mongolia is mainly governed through campsite access rather than by rights pertaining to pasture per se. Thus, the governance approach broadly reflects open property regimes (P4). With the new proposed pasture law, a shift to more community-based management (P3) is planned. Advantages and disadvantages of common management in comparison to open and flexible access regimes are active discussions (Fernandez-Gimenez et al. 2008; Hannam 2014).

(4) Reported outcomes: The flexible access regulations seem largely conducive with Mongolian customary institutions, though the issuing of lease certificates was reported to not be implemented on large scales (Murphy 2011). Compared to the neighbouring Inner Mongolia, the general rangeland management approach has led to greater mobility and less rangeland degradation (Sneath 1998). Additionally, more recent assessments confirm that severe livestock-induced degradation is comparably rare in Mongolia (Jamsranjav et al. 2018). However, authors note a lack of planning and management resulting in overgrazing and degradation, especially in productive areas (Fernandez-Gimenez et al. 2008; Jamsranjav et al. 2018). Case studies on community-based management approaches showed mixed results (Upton 2009; Addison et al. 2013; Fernandez-Gimenez et al. 2015), although a recent large-scale and representative study could verify improvements in grazing management practices (Ulambayar et al. 2017).

4.10. China (Inner Mongolia)

(1) Forms of pastoralism: With its location on the Mongolian Plateau, Inner Mongolia shares the same ecological system with the Republic of Mongolia. Steppe and semi-desert regions have supported historically nomadic, horizontal pastoral systems. However, in Inner Mongolia, livestock management has been largely changed to stationary systems or systems with reduced mobility (Chen et al. 2018).

(2) Governance approach: The former collective management approach was replaced by the "household responsibility system" or "grassland contracting policy" in the

early 1980s (B. E. Robinson et al. 2017; Li and Huntsinger 2011). The system involved long-term lease contracts to livestock and pasture areas, as well as fencing of rangeland plots (Taylor 2006). While initially a privatization of livestock and grassland to herding groups was possible, the associated settlement of nomadic groups led to an individualization of households, which resulted de facto in a privatization of land and livestock to individual households (Li and Huntsinger 2011).

Since 2000, the existing individual rangeland access system has been complemented by laws and decrees increasingly aiming at a stronger regulation of stocking rates to combat rangeland degradation, e.g., with the "grassland-livestock balance regulation" and "forbidden grazing and rotational grazing program" (B. E. Robinson et al. 2017). Additionally, compensation schemes (payments for ecosystem services) aiming at lower stocking rates on rangelands were set up (B. E. Robinson et al. 2017). Further policies aim to encourage cooperation among herders in anticipation of fragmented family holdings merging into larger holdings (Chen et al. 2018).

(3) Relation to rangeland paradigms: The introduction of the household responsibility system in the 1980s was clearly motivated by the narrative that grassland degradation is caused by a Tragedy of the Commons (Li et al. 2007; Taylor 2006), resulting in an effective privatization of pastures (P1). The policy changes after 2000 are characterized by a stronger position of the state and complementary policy mechanisms, setting positive incentives for grassland conservation based on classical market economic measures of environmental policy (P1, with aspects of P2).

(4) Reported outcomes: The privatization strategy led, until 2000, to an unanticipated extent of rangeland degradation in Inner Mongolia, likely to be caused by fragmentation, fencing and disrupted mobility (Li and Huntsinger 2011) and also associated with adverse social consequences (Yu and Farrell 2013). Incomplete privatization led, on remaining common lands, to severe degradation known as the "tragedy of enclosure" (Williams 1996).

In a review of the scientific literature addressing the impact of government policies published by IIED, Li et al. (2014) find that most authors of the newer literature (2008–2012) evaluate the "grassland contracting policy" in a negative way, leading to adverse changes in environmental, livestock management and social issues. However, some improvements on the socio-economic situation of herders were also reported (B. E. Robinson et al. 2017). While grazing bans and rotational grazing were assessed primarily as positive in combating degradation (see also Li et al. 2012), the policy had largely negative impacts on herders' livelihoods and the pastoral society

(Li et al. 2014). Li et al. (2014) assert that lacking knowledge on pastoralism among policy makers is the root cause for inappropriate rangeland policies.

5. Discussion

This contribution reviewed governance approaches to rangeland management in ten CAC countries and related them to international paradigms of rangeland management as described in the scientific literature and to outcomes with relevance to rangeland degradation. The results are influenced by the methodical approach: only published material in the English language was taken into account. Drawing on local language material or primary data might have led to more detailed assessments of the specific governance approaches in the individual countries, but is beyond the scope of this review. As evaluations of socio-economic and ecological outcomes are based on qualitative assessments by authors of publications, they especially highlight impacts of the governance regime based on authors' perceptions; however, comparisons of statistical or field data may provide additional insights. Table 1 provides an overview of the information presented in Section 4 and facilitates the comparisons discussed in the following.

In the ten CAC countries, diverse forms of pastoralism existed, which were adapted to the ecological conditions in the respective countries; however, these pastoral forms underwent massive changes during the socialist period and in post-socialist transition. Drawing on mobile livestock keeping, pastoralists are able to use variable forage resources in space in time (Scholz 1995). Vertical pastoral migration systems occur wherever mountain environments allow for it in the CAC region. Longer and horizontal mobility forms can be found in Central Asia (especially in Kazakhstan, Uzbekistan, Mongolia and Inner Mongolia).

Ecologically, there is a tendency towards drier ecosystems and to increasing continentality and non-equilibrial ecological conditions from west to east in Central Asia. The measure for climate variability, the Coefficient of Variation of precipitation, typically exceeds 33% under non-equilibrial conditions. In the western part of the CAC region, in Azerbaijan, the Coefficient of Variation ranges between 28% in semi-desert regions and 22% in mountain regions (Peper 2010). In arid and semi-arid regions of Uzbekistan, the indicator ranges between 27 and 34% (Gintzburger et al. 2005), while it is 47–50% in desert-steppe regions and 28% in mountain steppe regions in Mongolia, which indicates the tendency towards non-equilibrial ecosystem conditions in the eastern parts of Central Asia (Fernandez-Gimenez and Allen-Diaz 1999). However, the general east–west gradient is overlaid by elevational differences in mountain regions, which have higher precipitation and mostly lower Coefficients of

Table 1. Summary of forms of pastoralism and rangeland governance approaches in the Central Asia and the Caucasus region (CAC) region.

CAC Countries	Forms of Pastoralism	Rangeland Governance Approaches	Relation to Paradigms of Rangeland Governance	Reported Outcomes
Georgia	Transhumant, vertical pastoralism, partly agropastoralism	Mixture of private, leased and open access plots, frequent changes of management approaches, since 2008 majority of pastures under state jurisdiction, planned privatization	Frequent changes in pasture governance, privatization of pastures planned (P1)	Insecurity of land users, mix of overgrazing and undergrazing
Armenia	Transhumant, vertical pastoralism, partly agropastoralism	Rangelands initially under state jurisdiction, in 2003 transfer to local management, no privatization allowed	Initial policy search process involving strong state control (P2) and privatization intentions (P1), currently common management (P3) as a goal, provisions for community participation to be developed	Mainly degradation due to infestation of weeds, lacking mobility
Azerbaijan	Transhumant, vertical, partly agropastoralism	Distant rangelands under regional government with lease options; village pastures under local (community) management	Lease system with aspects of strong state control (P2) and private management (P1), on village pastures common management (P3) as a goal, few provisions for actual community-based management	High use pressure, degradation on village pastures, mobility enabled
Turkmenistan	Transhumant (historically semi-nomadic) radial pastoralism	Rangelands and partly livestock under state jurisdiction, devolution of management rights to herders, change to individual or community-based lease and management planned	Livestock lease system with strong position of the state (P2) and effective devolution of rights resulting in open property (P4), change to individual (P1) or community-based lease and management (P3)	Contradictory reports on patterns of pasture degradation, mobility enabled
Kazakhstan	Transhumant (historically nomadic), horizontal and vertical pastoralism, in mountain regions agropastoralism	Rangeland initially under state control with leasing options, since 2003 a variety of access options ranging from purchase to community access depending on type of pasture or facility	Initially lease options (P2), later mixture of 3 approaches (P1–3) dependent on resource characteristics	Underuse in remote areas, overuse in accessible areas, insufficient mobility

Table 1. *Cont.*

CAC Countries	Forms of Pastoralism	Rangeland Governance Approaches	Relation to Paradigms of Rangeland Governance	Reported Outcomes
Uzbekistan	Transhumant (historically nomadic), horizontal pastoralism, in few mountain regions agropastoralism	Rangelands under jurisdiction of farmer associations or district governments, in 2019 development of community-based management	Strong position of the state (P2), in 2019 change to community-based management (P3)	Scarce information, most probably underuse of remote areas, overuse in accessible areas
Kyrgyzstan	Transhumant, vertical pastoralism, partly agropastoralism	Initial approach with state ownership and lease options was replaced in 2009 by a community-based management approach	Initially strong position of the state with individual lease options intended (P2), in 2009 change to community-based management (P3)	Initially underuse in remote areas, overuse in accessible areas, still partly lacking mobility
Tajikistan	Transhumant, vertical pastoralism, partly agropastoralism	Initial approach with privatization and lease options, since 2013 parallel existence of individual and group access options	Initially strong position of the state (P2), privatization options not implemented (P1), community-based solutions in testing phase (P3)	Underuse in remote areas, overuse in accessible areas, inconsistencies in legal framework
Mongolia	Nomadic, horizontal and vertical pastoralism	State ownership of pastures, combined with individual and group access options to campsites, promotion of community-based management options	Lease of campsites broadly resembles open property regimes (P4). Planned change to more community-based management (P3)	Overuse in productive areas, social and ecological improvements proven in pilots with community-based management
China (Inner Mongolia)	Historically nomadic horizontal pastoralism, reduced to transhumant or stationary forms	Individualized pasture access and settlement of mobile pastoralists, since 2000 environmental policy based on state regulation and market mechanisms	Clear motivation to privatization related to tragedy of the commons (P1), in 2000 policy change to stronger focus on economic incentives for prevention of degradation (P1, with aspects of P2)	Privatization led to breakdown of mobility and strong degradation, recent social and ecological improvements

Source: Table by authors.

Variation. Thus, in general, most variable climatic conditions, to which nomadic forms of pastoralism are best adapted, can be found on the Mongolian plateau (Mongolia and Inner Mongolia) (Fernandez-Gimenez and Allen-Diaz 1999; Fernandez-Gimenez et al. 2017). While from a cultural–evolutionary perspective, an adaptation of livestock keeping practices and culture to environmental conditions can be assumed, current policy changes seem to be mostly driven by other factors, such as interests of political actors, prevailing narratives of how to achieve growth in the livestock sector and prevent degradation as well as the influence of international NGOs (S. Robinson et al. 2017b).

Current forms of pastoralism are shaped by historical conditions, whereas a tendency towards reduction and regularization of mobility over the last century can be observed. This is most expressed in Inner Mongolia, where an originally nomadic pastoral system was transformed by externally imposed policies to partly settled forms, leading to a livestock keeping system of a completely different character (Wang et al. 2013). This general reduction in mobility can be observed in pastoral systems worldwide (Scholz 1995; Humphrey and Sneath 1999).

In post-socialist transition in all ten CAC countries, similar developments in pastoralism can be observed. Nearly all countries saw a decline in and subsequent recovery of livestock numbers and changes in herd structures, which was associated in many cases with a reduction in mobility. In concurrence with the decline in livestock numbers, a retraction of mobility was observed: the small herds owned by one household were not worth being driven to remote pastures, as enough forage for them was available in the vicinity of villages (Farrington 2005; Robinson et al. 2010; Kerven et al. 2003). In addition to small livestock possessions, the lack of transport means was a contributing factor to decreased mobility.

After the initial decline, mobility patterns started to reverse: wealthier families began again to use remote pastures in order to satisfy the fodder demand of their large herds (Kerven et al. 2003, Farrington 2005, Kerven et al. 2016a, 2016b). In addition, common herding regimes started to emerge, which allowed households with few livestock possessions to participate in mobile pastoralism. Common herding practices may be officially recognized by the rangeland governance regime (e.g., Kyrgyzstan, Turkmenistan) or arise informally in spite of the absence of a legal framework (e.g., Tajikistan, Azerbaijan; Steimann 2011; Watanabe and Shirasaka 2016, 2018; Kasymov and Thiel 2019; Lunch 2003; Robinson et al. 2018; Allahverdiyeva 2017).

In rangeland governance, over the last 20–30 years, search processes for the appropriate regime can be observed, with a diversity of approaches existing today. There is evidence for all four paradigms of rangeland governance, for private,

state, common and open property, often combined in hybrid governance regimes. Enabling private or individualized access to rangelands (P1) occurred during the initial transition phase after 1990, providing a legal frame for the privatization of rangelands in Georgia, Tajikistan and Inner Mongolia. However, if individualized access was enabled, de facto distribution of rangelands rarely occurred due to low demand and the decline in livestock and mobility in the initial transition period. Thus, nearly private property rights for pastures are de facto established only in Inner Mongolia and are still planned for Georgia. To avoid a Tragedy of the Commons is clearly spelled out as the motivation for enabling private property rights in advisory documents of international development organizations and the scientific literature. Evidence for this is found for a range of countries, e.g., for Georgia in a World Bank report (Welton et al. 2013), for Mongolia as expressed by the Asian Development Bank and the Democratic Party (Goldstein and Beall 1994 and Sneath 2000 cited in Murphy 2011) or for Inner Mongolia (Taylor 2006; Li et al. 2007). Individualised lease, which resembles privatization if most management rights are transferred, is still a major pillar of rangeland governance in many countries (e.g., Armenia, Azerbaijan, Kazakhstan and Tajikistan).

Whether individualised lease options were implemented depended partly on other factors influencing the demand for pastures and re-establishment of mobility: individualised lease options were rapidly implemented in Azerbaijan due to the dynamic economic development in the country based on the exploitation of oil reserves and comparably scarce pasture resources (Neudert et al. 2015). In contrast, in Tajikistan or Kazakhstan, the implementation of lease options is still incomplete due to the difficult economic environment (Tajikistan) and vast pasture resources in both countries (Kerven et al. 2016b; Jaborov et al. 2017).

Another common approach in the initial transition period was to keep many features of the Soviet style of rangeland governance (P2), which indicates a path-dependency of governance regimes. This is exemplified particularly by the state ownership of rangelands and partly continuing existence of collective farms (e.g., Azerbaijan, Armenia, Kazakhstan, Uzbekistan and Tajikistan). In extreme cases, the state even retained access to livestock, as exemplified in Turkmenistan. In later stages, the approach was complemented by a gradual devolution of rights, either by a change to community-based management (Uzbekistan, Armenia) or to individual users with effective flexible and open rangeland access options (Turkmenistan, where it arose as a side effect of the formal governance regime).

Some countries changed or complemented the initial individual access or strong state control approach in the later stages of post-socialist transition with

community-based rangeland management (P3): this is most clearly expressed in the example of Kyrgyzstan, which changed the rangeland governance paradigm from an individual lease to a community-based approach in 2009. Based on the example of Kyrgyzstan, Kazakhstan, Uzbekistan, Armenia and Tajikistan also complemented their rangeland policies with community-based approaches at least for pastures in the vicinity of villages. In many countries, international development organizations played and continue to play a major role in advocating and implementing the approach, e.g., the World Bank and IFAD in Kyrgyzstan (Kasymov et al. 2016), Asian Development Bank, IFAD and World Bank in Tajikistan (Jaborov et al. 2017), World Bank in Armenia (Christen 2020) or diverse donors in Mongolia, among them World Bank and Swiss Development Cooperation (Undargaa 2017). Cases of policy adoption from experience in other countries, e.g., in Tajikistan following the example of Kyrgyzstan (Jaborov et al. 2017), exemplify processes of policy diffusion and convergence in rangeland policies within the CAC region (Busch and Jörgens 2005).

However, as the examples of Azerbaijan and Armenia illustrate, community-based management does not appear spontaneously immediately after handing over management responsibilities to local communities. A legal framework for community-based management must be complemented by the facilitation of community-based decision making supported by tools and trainings for participatory pasture monitoring and the establishment of grazing management plans. Thus, implementing community-based approaches requires supporting measures, well-designed implementation rules and meaningful monitoring of participation activities in the long run (Crewett 2015; Gruber 2010).

The paradigm of open property regimes (P4) is seldom represented in the CAC countries, as it appears as part of the governance regime only in Turkmenistan and Mongolia (Table 1). The paradigm seems most suitable under non-equilibrial ecosystem conditions (see Section 3.4), which are most expressed in Mongolia and Inner Mongolia. Only Mongolia partly followed this approach with the distribution of lease contracts for campsites. In the discussion of the new pasture law where a shift to more widespread community-based management is planned, concerns for flexible access regulations are expressed. As a special case, Turkmenistan was able to complement a system with strong state control with an effective devolution of access rights, thus enabling an open property regime. Moritz et al. (2018) also state that pastoralism in Mongolia and Turkmenistan exhibits features of open property regimes.

As visible in many policy approaches, rarely one paradigm of rangeland management is implemented to the full extent. Rather, approaches are mixed

across scales, particularly depending on the type of pasture resource concerned (L. W. Robinson et al. 2017). In many cases, regulations for remote or summer pastures differ from the governance of winter pastures or pastures in the vicinity of villages. Changes and refinements according to types of pastures are also reflected by the time scale. These policy changes and refinements leave the impression of search or trial and error processes to find the appropriate approach for rangeland governance in the respective countries to balance secure rights, mobility and flexibility. These processes are clearly not yet complete.

The review of outcomes, especially on the ecological condition of rangelands, shows a mixed result. The actual extent of pasture degradation in the individual countries is controversially discussed and strongly depends on the different definitions of degradation and methodological approaches used (Jamsranjav et al. 2018; Briske 2017). As irreversible degradation develops over a longer time period, historical use patterns and livestock number should also be taken into account. In the early period of post-socialist transition, an improvement of pasture conditions was noted caused by the decline in livestock numbers followed by an increase in use pressure more recently (see examples of Kazakhstan: S. Robinson et al. (2017a), or Mongolia: Khishigbayar et al. (2015), S. Robinson (2016) for a review for Central Asia). In addition to livestock-induced degradation, climate change may also have negative effects on pasture conditions, altering ecological processes of grassland ecosystems (e.g., in the example of Mongolia: Khishigbayar et al. (2015), Fernandez-Gimenez et al. (2017)).

Recurring patterns noted as problems in rangeland management are overused areas in the vicinity of settlements and underused plots in remote areas. Thus, mobility is a crucial aspect for sustainable rangeland management (Zinsstag et al. 2016; Coughenour et al. 2008). A governance regime can enable or inhibit mobility. This is most clearly illustrated by the example of rangeland governance in Mongolia and Inner Mongolia, where one ecosystem is governed by two very different governance regimes: it was shown that degradation processes are more severe under individualized and settled rangeland management in Inner Mongolia and Russia compared to Mongolia, where pastoralists have maintained at least some degree of mobility (Sneath 1998; Li et al. 2007). In addition, degradation processes were found to be especially severe around enclosures, which are viewed as a threat to the sustainable management of rangelands (Williams 1996; Taylor 2006). Thus, enabling mobility is clearly a crucial aspect in the design of governance regimes for mobile pastoral systems.

However, several examples show that mobility can be maintained under very different access regimes, such as the leasehold pastoral system in Turkmenistan, the strongly individualized lease system in Azerbaijan or the campsite lease system in

Mongolia. Only for a privatized governance regime an example enabling mobility is lacking, but can be imagined theoretically. In addition to ensuring the mobility of livestock owners with formal pasture access, especially in lease system, modes of pasture access for households with few livestock need to be found to enable mobility for all members of the pastoral community. This is frequently ensured with cooperative or common herding regimes. Thus, any access regime should be complemented with formal regulations or informal norms ensuring mobility and enabling cooperative herding agreements.

6. Conclusions

In the context of combating rangeland degradation and SDG 15, this contribution reviewed rangeland governance approaches in ten CAC countries in the post-socialist period and related them to four theoretical paradigms of rangeland governance and socio-economic and environmental outcomes. There is evidence for all four paradigms, private, state common and open rangeland access regimes. Often, actual policy approaches bear evidence for two or three paradigms, or the approach changed during the time period considered. Policy developments show a search process for appropriate rangeland governance regimes, with complete changes of approaches or with gradual amendments and refinements of existing policy approaches, while decisions seem to be strongly influenced by international development organizations in many CAC countries.

Rangeland degradation, though contested in definition and extent, is often associated with lacking mobility, overstocking and lacking maintenance of infrastructure by the publications reviewed. Depending on formal regulations as well as informal practices of herders, rangeland governance regimes can enable or inhibit mobility and flexible movements to react to droughts or severe winter weather. Governance regimes integrating common access to rangelands to some degree and providing legal possibilities for cooperative livestock management and herding also have a greater potential to enable mobility for households with fewer livestock possessions.

Based on this information, the lesson emerges that there is no silver bullet for sustainable rangeland management based on the paradigms of rangeland governance, as often suggested in the theoretical literature or promoted in the early stages of transition by international development organizations. Blueprint or ideologically driven approaches are seldom appropriate. Once a decision for a general approach is taken, it has to be amended depending on the socio-ecological conditions in the country and the practices of the pastoral population. Often trial and error processes

are necessary for gradually improving the legal framework and the fit to pastoral practices. Consultation processes with stakeholders seem to be one approach to improve frameworks; however, they can be time consuming, as the example of Mongolia's new pasture law illustrates.

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