



Pastoralism at Scale on the Kazakh Rangelands: From Clans to Workers to Ranchers

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Eurasia contains the world's largest contiguous rangelands, grazed for millennia by mobile pastoralists' livestock. This paper reviews evidence from one Eurasian country, Kazakhstan, on how nomadic pastoralism developed from some 5,000 years ago to the present. We consider a timespan covering pre-industrial, socialist and capitalist periods, during which pastoral social formations were organized in terms of kinship, collective state farms, and private farms and ranches. The aim is to understand how events over the last 100 years have led to the sequential dissolution and re-formation of the social units necessary to manage livestock across a wide expanse of spatially heterogeneous and seasonally variable rangeland ecosystems. It is argued that the social scale of extensive livestock management must be tailored to the geographical scale of biotic and abiotic conditions. The paper starts by pointing out the long duration of mobile pastoralism in the Kazakh rangelands and provides an overview of how events from the late 17th C onwards unraveled the relationships between Kazakh nomads' socio-economic units of livestock management and the rangeland environment. At present, mobile animal husbandry is not feasible for the majority of Kazakh livestock owners, who operate solely within small family units without state support. These reformulated post-Soviet livestock grazing patterns are still undergoing rapid change, influencing the composition of rangeland vegetation, wildlife biodiversity, and rates of carbon sequestration. By concentrating capital and landed resources, a minority of large-scale pastoralists have been able to re-extensify by combining mobility with selective intensification, including an increased reliance on cultivated feed. Current state and international efforts are leaving out the majority of small-scale livestock owners and their livestock who are unable to either intensify or extensify at sufficient scale, increasing environmental damage, and social inequality.

Keywords: pastoral mobility, Kazakhstan, kinship, Soviet Union, history, environmental impacts, nomads

INTRODUCTION

The Eurasian rangelands contain spatially heterogeneous, seasonally variable and climatically unstable natural resources extending over large geographical scales (Matley, 1994a). Over millennia, humans have been able to exploit these resources by matching the geographical scale of environmental variability with appropriate socio-political institutions for herding domesticated grazing animals on an extensive basis. These rangelands comprise the world's largest contiguous

area of grazing (Babaev and Orlovsky, 1985; Mirzabaev et al., 2016), comprising 25% of the world's total rangelands and over 6% of the total world land area (FAOSTAT “permanent pasture”) (see **Figure 1**).

At 1.9 million km² (FAOSTAT, 2020), pasture constitutes 86% of the agricultural land area of modern Kazakhstan. Most of this pastureland is semi-arid to arid, receiving <300 mm precipitation per annum (often in the form of snow rather than rain). The pastures cover multiple ecological zones, from sandy desert dominated by woody shrubs and ephemeral spring bulbs, to short and long-grass steppes on the plains, and alpine meadows grazed by livestock in summer at altitudes of up to 3,000 m (Gilmanov, 1996; Asanov et al., 2003; Van Veen et al., 2003). The climate is severely continental, with very cold and snowy winters in which temperatures may fall to −30C, and hot dry summers with maximum temperatures of 50C (ibid.). A defining feature of much of the pastureland is that arable agriculture is impossible without irrigation.

ARCHAEOLOGICAL EVIDENCE

Archaeological evidence indicates that mobile pastoralists and their livestock have occupied these lands for at least 5,000 years (Frachetti et al., 2012). The Eurasian region was the locus for the domestication of goats, sheep, horses, and Bactrian camels (Larson and Fuller, 2014; Taylor et al., 2020) between 10.5 and 4 thousand years ago. Recent interdisciplinary research by archaeologists, climate scientists and ecologists is uncovering more about the complex relationships between nomadic migrations, settled farming, climate change, and environmental conditions in the last millennia—“as scholarship focuses on the ways in which pastoralists, of various degrees of mobility, exploited geographically variable, and annually shifting climatic conditions to find pasture for their herds” (Brooke and Misa, 2020, p. 3). Since pre-historic times, nomadic pastoralist groups have tracked climatic changes and vegetation heterogeneity across ecozones, seasonally moving their livestock long distances latitudinally, shorter distances altitudinally (Khazanov, 1984; Gilmanov, 1996; Frachetti et al., 2012, 2017), or made relatively short-distance moves combined with significant use of foddering (Ventresca Miller et al., 2020a). Archaeological research in Kazakhstan suggests that in the prehistoric past, “pastoralist mobility was likely similar to what we see in the ethnographic record: seasonal mobility patterns of variable distance that brought populations between known ecological zones as they seasonally came into various stages of productivity” (Frachetti, 2015, p. 9).

The floral and faunal biodiversity and landscape conditions now present in the Eurasian rangelands is an outcome of millennia of human use through mobile livestock husbandry (Spengler, 2014), in combination with climate change, the adoption of new technologies, and changing socio-political institutions. In the human migrations of mixed herding and farming “sheep led the way” (Frachetti et al., 2012, p. 15) between 5000 and 2000 BCE¹ and “... while climate certainly played a role,

steppe cultures forged the pastoral systems that would exploit variations in the ecological uniformity of the grasslands. In so doing, they set in motion forces of anthropogenic change...” (Brooke and Misa, 2020, p. 17–18).

Against this archeological background, this paper examines the historical record over the last two centuries and outlines how pastoralist livestock management and land use systems in Kazakhstan have been altered by changes in socio-political institutions and economies. We argue that the geographical scale of environmental heterogeneity within the temporally and spatially varied climate regime of Eurasia has required particular kinds of social organization to effectively exploit rangeland resources. The social scale of extensive livestock management has had to match the geographical scale of livestock mobility required by the biotic and abiotic conditions. The present-day conditions on the Kazakh rangelands are the result of interactions between humans and livestock stretching back millenia. Sustaining the rangeland heterogeneity will require livestock-keepers to continue operating at scale, as documented by the environmental impacts of current declines in livestock mobility.

A Century of Dynamic Human Influence on the Kazakh Rangelands

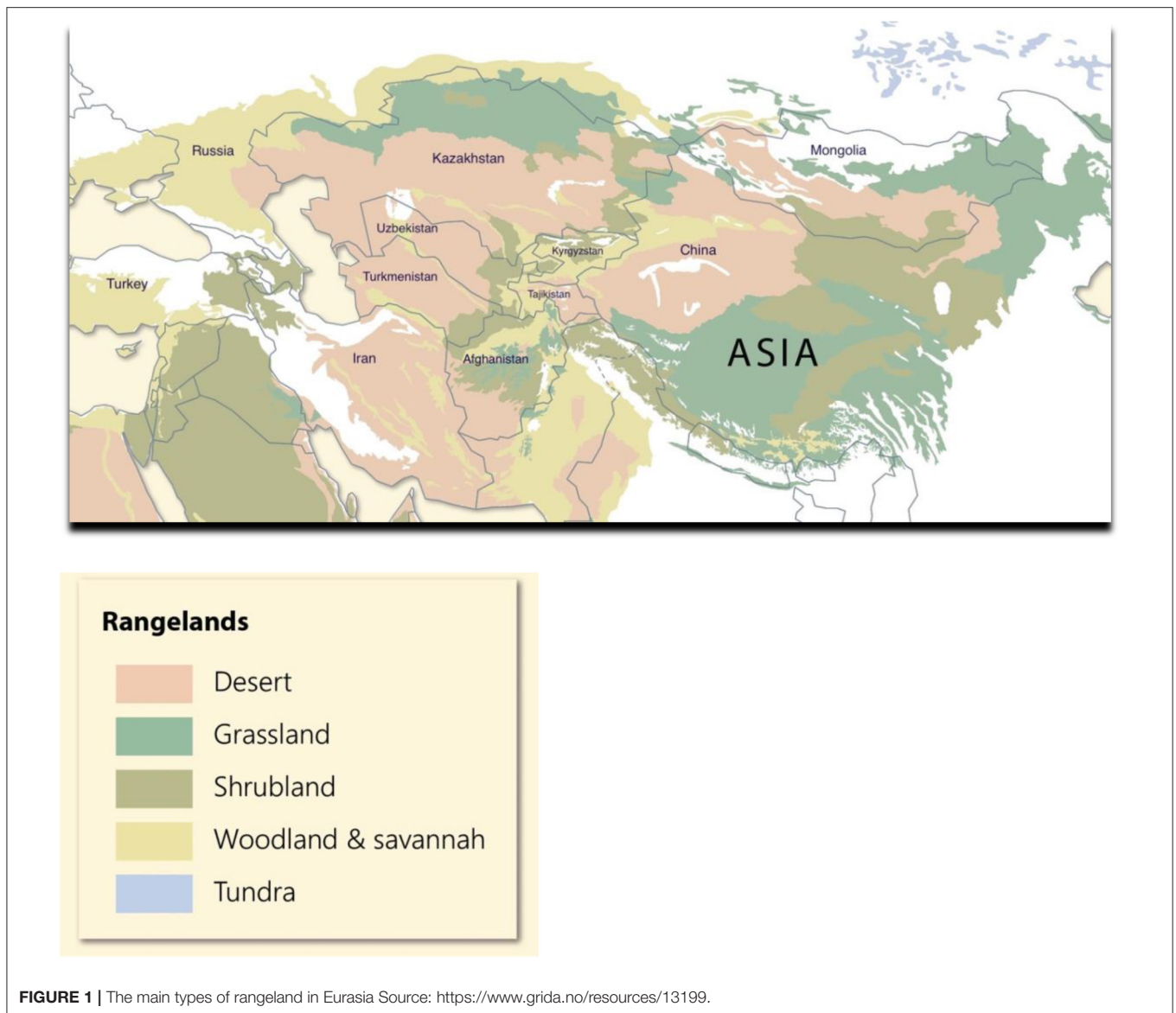
Starting with the early written record, we outline a chronology of three national socio-political upheavals over the last 100 years, each of which led to perturbations in the socio-political organization of pastoralism in the rangelands. In the 18th and 19th centuries, Kazakh pastoralists practiced pre-industrial nomadism, characterized by localized kinship-based production units operating within a hierarchical political organization. In the early 20th century these institutional arrangements were forcibly displaced by a collectivized socialist system in which the state assumed responsibility for supporting mobile husbandry. In the late 20th century, state socialism was replaced by a capitalist economy in which individual families employed private economic resources to maintain livestock mobility.

This century of changes in livestock management has left lasting effects on the rangeland ecology and on the pastoralists' economic, social and cultural life. The conclusion speculates about the changes that may be expected in the near future as a result of current institutional arrangements and management practices.

CLANS, CLIENTS AND SOCIAL STRATIFICATION

From the earliest explorers to present-day social scientists, descriptions of Kazakh social organization and customs have referenced “clans.” In this review, we use the generic term with an intentional absence of deep enquiry into its often subtle and changing meaning. Outsiders' interpretations of what is a “clan” [*ulu* or *ru* in Kazakh) has varied through historical periods, has been incorporated into opposed politico-ideological agendas, and is still debated among contemporary social scientists—particularly political scientists and social anthropologists (e.g., Schatz, 2004; Collins, 2006; Sneath, 2007). No doubt the concept

¹BCE is Before Common (or Christian) Era, formerly termed BC.



has undergone similar internal shifts in meaning throughout Kazakhs' own historical experiences.

Earliest written accounts by Russians about Kazakh clans (e.g., Levshin, 1832) were initially summarized in English language works such as Hudson (1938), and later in Olcott's magisterial work (1995). In the context of the social organization of Kazakh nomadic movements with livestock—the central enquiry of this review—these sources generally agree that regular seasonal movements to graze livestock in mobile encampments were undertaken by the *aul*, a co-residential grouping formed around a core of patrilineally related kinsmen. Here we could think of a clan as an opportunistic aggregation “flexible and scaled at multiple levels. Contingent upon prevailing ecological conditions and constellations of external threats” (Schatz, 2004, p. 27), groups would form and fracture at different times. Thus the size of the migratory unit changed over time as households

aggregated or dispersed according to season, pasture condition and labor requirements—with much larger aggregations in summer and smaller groups in winter (Masanov et al., 2001).

Still, having invoked the term, it behooves us to attempt some clarity in our application in this review, while remaining agnostic about the competing definitions. In the context of the social organization of Kazakh nomadic movements with livestock—the central enquiry of this review—these sources generally agree that regular seasonal movements to graze livestock in mobile encampments were undertaken by the *aul*, a co-residential grouping formed of members of a minimal segmentary patrilineage.

Intersecting and cross-cutting any discussion of kin-based nomadic livestock production systems—past and present—is the question of social stratification and class formations among Kazakh livestock-keepers. For the past, we only have written

records of views expressed by Kazakh informants but written in other languages by geographers, administrators, ethnographers, and historians at different stages in the turbulent and often violent political-economic changes of what has become the modern state of Kazakhstan. Ultimately, the extent of class-like divisions between Kazakh groups in the historical period remains hazy. Comparison with other pastoral peoples (e.g., Bradburd, 1980; Sikana and Kerven, 1991; Borgerhoff Mulder et al., 2010; Murphy, 2015) indicates that frequent cycles of livestock accumulation followed by losses due to climate events, disease, conflict or conquest lead to fluctuations in the membership of a livestock wealth strata. As families and even clans entered or left a livestock wealth strata among the Kazakhs, there were associated oscillations for required labor and means of survival among differentiated livestock-keeping groups. Such instabilities in the distribution of means of production for the Kazakhs—livestock and labor—were and are still handled through patron-client relationships. The rigidity of these relationships may be shallow, over time, however.

KIN-BASED NOMADISM IN THE TSARIST PERIOD

Starting in the late 1700s, we have written material from the Russian imperial period on how the Kazakh nomads managed their livestock by tracking between ecological zones to seasonally-available grazing areas in order to avoid areas of temporary feed insufficiency, snow and/or cold, and to take advantage of natural forage surpluses in other areas (Khazanov, 1984; Olcott, 1995). The nomadic pastoralists accessed the pasture and water resources of the rangelands in extended family groups that moved and resided together in each season (Olcott, 1995; Aldashev and Guirkinger, 2017). Termed *aul*, these groups consisted of between 5 to 80 yurts (portable felt tents made from sheep wool) and had settled winter quarters made of durable materials (e.g., mud bricks and wood). The characteristics of the environment and the availability of water and pasture resources had an impact on the size of the camps because these factors determined the size of the herd that each *aul* possessed (Ohayon, 2004). A Kazakh nomadic camp in southwest Kazakhstan was photographed around 1860 (Figure 2).

The *aul* consisted of several conjugal families founded by direct male descendants of the same ancestor, hence a patrilineage (Ohayon, 2005). The *aul* was headed by elder men known as *aksakal* (literally “white beard”), who were charged with the protection of his pasturelands and people (Olcott, 1995). The elders would choose an individual termed *bii* to represent the clan in negotiations between other clans and *auls*, meet annually to decide on the routes for the season’s migrations and allocate access to winter pastureland. The *bii*s were expected to defend their groups’ access to pastures, as well as arbitrate disputes (Martin, 2001). They were lesser nobles who represented lineage groups of Kazakh nomads in negotiating annual migratory routes between clans, and also had a military role (Martin, 2001). A collection of groups “which might consist of 100 *auls* or more,

migrated within an established geographic zone” (Olcott, 1995, p. 17).

This scale of nomadic movements managed through kin-centered social units started being curtailed when the northern pastures of the Kazakh nomadic pastoral tribes were effectively brought under the control of the Russian government, fortified and made available for settlement by Slavic peasants (Wendelken, 2000; Khodarkovsky, 2002). The colonial settlers’ occupation in the 18th and 19th C of the fertile steppe used seasonally by Kazakh nomads became a “decisive destabilizing factor for the Kazakhs” (Kappeler, 2001, p. 189). As the extent of new Slavic peasant farming moved further south from the Russian borders, the nomads had to retreat with their livestock to the drier southern areas. “As far as the Russian government was concerned, the newly acquired lands were empty spaces belonging to no one...for the [Kazakh] nomads on the other hand, the same lands were indispensable pastures in common possession of the *ulus* [clans] or another aggregate nomadic unit” (Khodarkovsky, 2002, p. 216). When confronted with demands by the Russian frontier authorities to seek permission to use pastures and pay fees for crossing the rivers of the northern steppes, the Kazakhs responded with astonishment: “The grass and water belong to Heaven and why should we pay any fees?” (ibid.).

In the 19th C, numerous regional variations of nomadism and semi-nomadic pastoralism were recorded by Russian ethnographers and administrators in the territory that later became Kazakhstan (Federovich, 1973; Guirkinger and Aldashev, 2016; see Figure 3). The pastoralist mode of production varied according to three main factors: type of terrain (plains vs. mountains), climate regime (arid to wetter), water supplies (rivers and ground water), and associated pasture soils and vegetation. The plains-based nomadic economy depended on long distance migrations with grazing livestock, extending up to 1,000 km or more (Federovich, 1973) on a north-south axis throughout the year, traversing between the northern steppe, semi-desert, and desert in the south, where overwintering took place. Semi-nomadic groups also existed with permanent winter quarters. The mountain-centered livestock production system involved vertical transhumance, with settled winter bases in the valleys or semi-steppes around the mountains and transiting upland to alpine meadows for pasturing in the summer, with distances between summer and winter pastures often over 100 km (ibid.).

There were social distinctions according to a family’s economic position in the community, in addition to an aristocratic genealogically-calculated hierarchy [see detailed discussion in Martin (2001), based on earlier sources]. The former aristocratic rulers (White Bones) were mostly co-opted or subjugated in the Tsarist period. By the late 1800s, Russian administration had eroded the large territorial and political units of the Kazakh upper levels of aristocracy, including the *bii* (Wendelken, 2000). At this time, the term *bii* seems to have become transcribed as *bai* [e.g., in Olcott, 1995]. *Bai* is a general Kazakh term for a rich person, who would own many livestock; possibly this conflation of terms may have occurred as the Russian administrators sought to co-opt the *bii* (Ohayon, 2005;



FIGURE 2 | Nomad migration, Syr Darya Oblast circa 1860 (now present-day Kazakhstan) Source: Turkestan Album, 1860s https://www.wdl.org/en/item/10987/#additional_subjects=Ethnographic%20photographs&page=7. This photograph is from the ethnographical part of *Turkestan Album*, a comprehensive visual survey of Central Asia undertaken after imperial Russia assumed control of the region in the 1860s. Commissioned by General Konstantin Petrovich von Kaufman (1818–1882), the first governor-general of Russian Turkestan, the principal compiler was Russian Orientalist Aleksandr L. Kun, assisted by Nikolai V. Bogaevskii.

Sneath, 2007), who were elites in the Kazakh social structure. The position of *bais* (*bailar*; *kz*) as local leaders was strengthened as some Kazakh nomads began to settle into villages and Russian authorities empowered and paid the *bailar*, in a form of indirect rule, to collect taxes and maintain social order for the Russian administrators (Wendelken, 2000; Ohayon, 2005). As the *bii* became richer through Russian contact, a *bii* could be termed a rich man—a *bai*—as a consequence. As Russian settlement in the northern regions disrupted the Kazakh migratory routes, this lessened the larger-scale patronage and defensive ties which had previously existed between *auls* and higher-level social units, by breaking up the large territories of political power within a hierarchical social system (Martin, 2001). This increased Kazakhs' dependence upon their smaller *aul* groups, and a

new social production system emerged based around the *aul obshchina* (*ru*) or “community,” a partly-sedentarised community based on communal land use and herding of livestock.

Some of the need for nomadic movement was reduced when in the latter 19th C, the influx of Russian settlers and traders in the north created new markets for Kazakh livestock, particularly cattle, and in response, Kazakh pastoralists started to keep more cattle in addition to sheep in the northern steppe regions adjacent to the Slavic settlers (Olcott, 1995). But cattle, being less suited to long-distance migrations to avoid the worst of the frigid winters, needed more supplementary feed. Some intensification of pastoralism then occurred, when adoption of scythes, more efficient than the pre-existing hand sickles, permitted richer Kazakh nomads to harvest more hay to sustain their livestock,

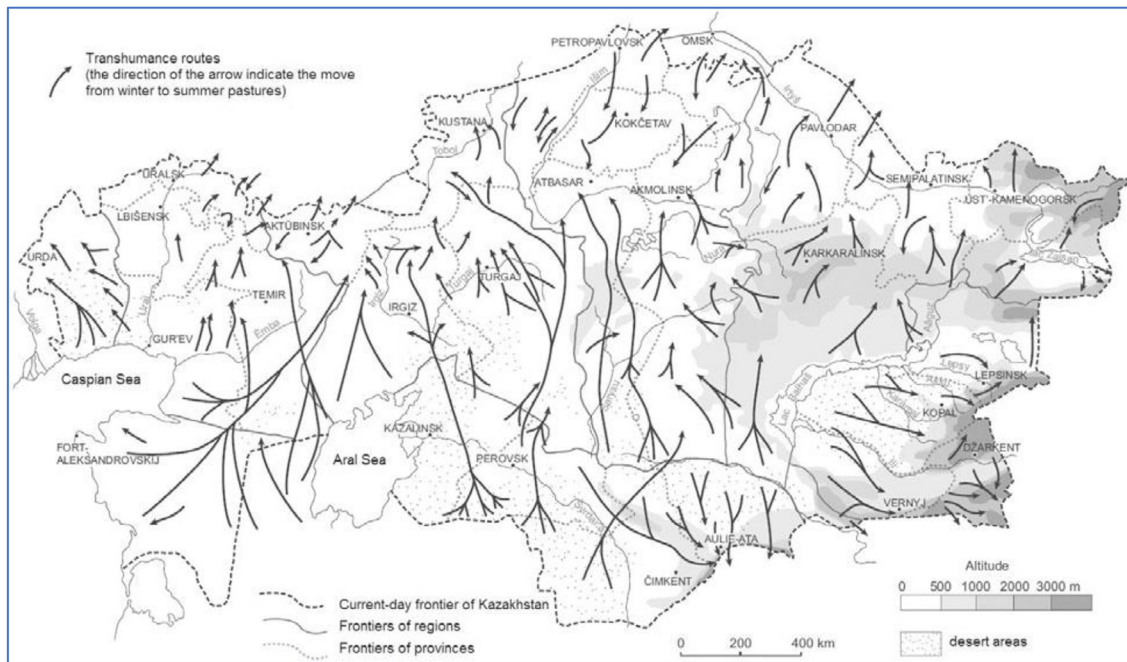


FIGURE 3 | Kazakh nomadic seasonal movements at the end of the 19th C. Source: Kerven (2004), Ferret (2014), based on (Federovich, 1973).

especially cattle, over the long bitter winters. One effect was to lessen the need for longer migrations to warmer locations and permit households to keep more animals (Kazakh Academy of Sciences, 1980; Matley, 1994b; Aldashev and Guirking, 2017). Thus, greater Kazakh sedentarization was possible and in some cases necessary, due to the expropriation of pastures by the Russian administrator for Slavic settlers (Kazakh Academy of Sciences, 1980). Wealthier Kazakhs even began to use hay mowers and hayland was one of the first types of agricultural land which richer Kazakh pastoralists sought to secure for exclusive use (ibid.).

Commercialization led to increasing economic differentiation among Kazakh pastoralists as livestock wealth became more concentrated into the hands of a few *bailar*, who had gained more recognized local level political power. “An increasing percentage of the total herd was held in an ever smaller number of hands” (Olcott, 1995, p. 99). However, even by the 1920s in northern Kazakhstan, the social and economic patronage obligations between richer and poorer related families in an *aul* meant that, as one elderly informant noted “rich people’ does not mean one person” (Kerven, 2003). Different *auls* would be richer or poorer in livestock, with one richer and senior male in the lineage responsible for decisions on livestock management. The historical records of that period confirm this (Ohayon, 2005). By the end of the 19th C the number of yurts in an *aul* was reduced to 4 or 5 on average, while richer families, with larger herds and flocks, incorporated poorer people who carried out basic tasks in exchange for their upkeep in the *aul* encampment (Ohayon, 2004).

ENVIRONMENTAL IMPACTS OF THE RUSSIAN COLONIAL PERIOD ON THE RANGELANDS

For the course of the Tsarist Russian period, there is scant evidence on environmental impacts of the changes to Kazakh mobile pastoralism wrought by the two major land use alterations: increasing colonization by Slavic peasant farmers which reduced nomadic access to the better-watered steppes, and the trend among Kazakh nomads to partially settle and grow feed and fodder crops. One historian’s view was that “The nomadic livestock raising upon which was based the economy of desert region was so well-adapted to natural conditions that the landscape was very little modified, even in the sandy deserts which are very sensitive to the modification by man” (Federovich, 1973). Masanov (1990) likewise suggests that this system is one reason why environmental impact during this period was so minimal, as grazing pressure tracked vegetation availability without causing a negative impact on the environment.

Moreover, as livestock in the Eurasian rangelands were periodically decimated by ice and snow disasters (*dzhut* Kz), these non-equilibrium climatic conditions limited overall numbers and made serious degradation highly unlikely whilst livestock remained mobile (Sludskii, 1963; Robinson et al., 2003; Kerven, 2004). Severe cases of *dzhut* causing high stock mortality occurred every 10–12 years in the pre-Soviet period, according to Sludskii (1963) who noted that stock numbers would take around 10 years to recover from these events, leading to significant expansion and contraction in numbers. Herbivores in a

non-equilibrium climate regime such as Kazakhstan's rangelands are less likely to threaten their overall feed supply since ecological carrying capacity is never reached, without supplementary feed sources (Ellis and Lee, 2003). This situation was to be completely upturned from the 1950s onwards, as we shall discuss later.

COMPRESSION AND COLLECTIVIZATION OF THE NOMADS: EARLY 20THC

Throughout the latter period of Tsarist Russian administration of Kazakhstan's northern regions, this land "had long been viewed as a source of new farms. In the period 1896–1916 it received over one million settler families from European Russia" (Olcott, 1981, p. 124), mainly to the better-watered steppe region of rich grassland which had been the summer grazing area of Kazakh nomads. But the temporary nomadic use of the steppes was "seen as a hindrance to the expansion of grain-growing, as the animals grazed on hundreds of thousands of acres of potential farmland. The colonial settlement policy caused great hardships for the Kazakhs as it severely restricted the access to pasturage... When the Bolsheviks came to power they made the settlement of the Kazakh nomads an avowed goal" (ibid.).

However, the Bolshevik revolution in 1917 did not immediately change the situation of the nomads and semi-nomads in the Russian-controlled regions of Kazakhstan, as Russian peasants continued to settle further south into the territory (Allworth, 1989). The area of modern Kazakhstan was formally incorporated into the new Soviet Union in 1924. The Russian census of 1926 (just before collectivisation) found that summer migration concerned 65% of the Kazakh population and long distance multi-season migrations only 7–8% (Ohayon, 2004). The frequency of hay making, a propensity to hold cattle and the proportion of entirely sedentary households all increased in this early colonial period—by 1910 it was estimated that only between 2 and 10% of Kazakh households were sedentary (Kazakh Academy of Sciences, 1980).

Some Russian administrators had argued that the nomadic pastoral way of life was a form of environmental adaptation, and that as long as the environment did not change, nomadic pastoralism would continue to exist (Werner, 1997, citing Russian sources). In the 1930s, however, Soviet academics claimed that nomadic societies had developed class relations before the Bolshevik revolution, tribal leaders in nomadic pastoral societies were feudal rich people—*bailar*—and that nomadism was not efficiently productive (ibid.).

Fluidity of socio-economic strata is mentioned in (Hudson, 1938) writings at a particularly dreadful time in modern Kazakh history (p. 58). "The poor or middle-class Kazak was always in a precarious situation because the loss of his few cattle placed him in complete subjection to the wealthy owners of large herds." Radlov, writing in 1893, observed that "a Kazak who had lost his animals through drought or a severe winter had no resource but to hire himself out as a worker" (Hudson, 1938, p. 58). These herders did not receive a salary but only food. Such people were referred to as clients of a rich man, and the clients were "his

own more or less distant relatives." Another Russian commentator, Grodekov noted in 1889 that "in strong tribes, the poor people migrate with the rich, remaining always with their group for the sake of the protection afforded by the rich, paying for it with labor" (cited in Hudson, 1938, p. 58).

Under the new Communist government, collective farms termed *kolkhozy* were started from 1924, as communes were formed around the semi-settled villages governed by the *bailar* to control livestock, migratory movements, and water points. Then began the brutal programme of enforced nomadic settlement and expropriation of livestock in "the drive for collectivization" (Olcott, 1995). In 1928, under Stalin, livestock began to be confiscated from Kazakh families and placed into *kolkhozy*. This was the period known as "Stalin's Terror" and the great famine ensued from 1931 to 1934 in Kazakhstan (Kindler, 2018; Thomas, 2018).

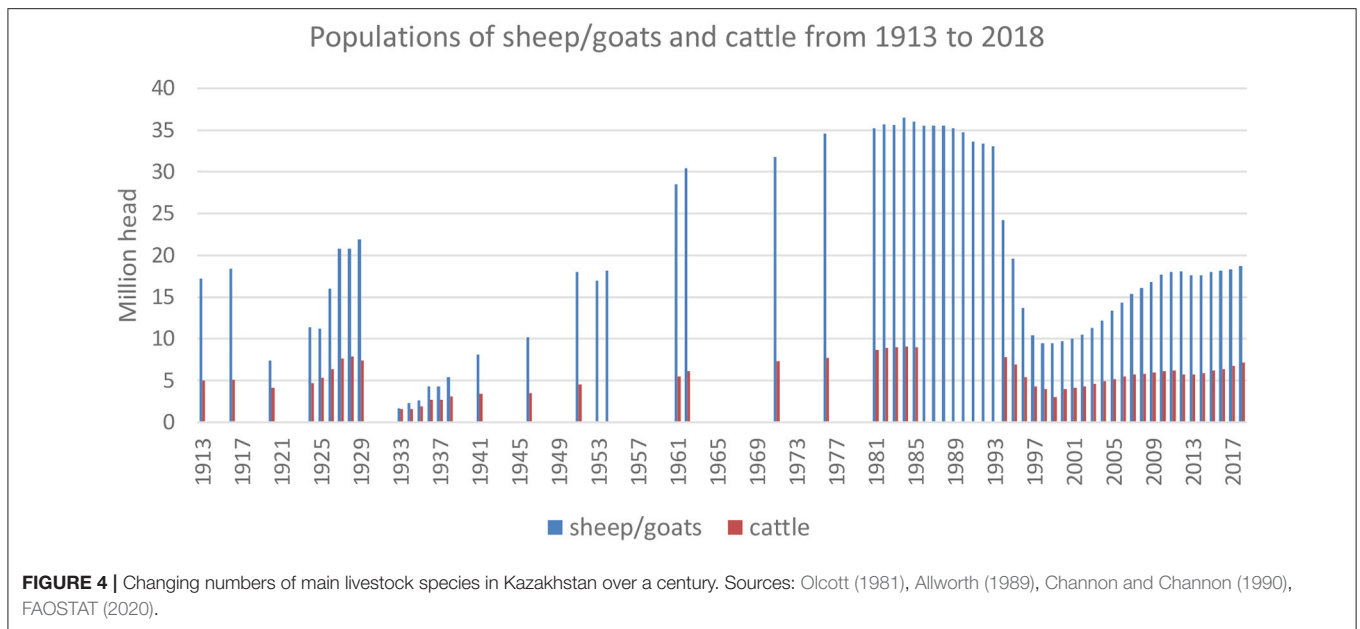
From 1930, the main means of Kazakh collectivization was "dekulakization," the removal from villages of allegedly "well-off" exploitative peasants—kulaks—and others who opposed too openly the program of collectivization, as officials considered dekulakization necessary to enable collective farms to work (Conquest, 1986, p. 193). Among those accused of being kulaks were some of the Kazakh *bailar* who had accumulated livestock wealth under the previous Russian administrative regime, and were then denounced by settled ex-nomads (Thomas, 2018).

There were enormous consequences for Kazakh pastoralists of the radical methods for collectivizing pastoral regions and enforced sedentarization (Lorimer, 1946). Among the impacts was lack of available fodder for winter in the collective farms, as livestock were not taken to winter pastures (Davies and Wheatcroft, 2004). There was a catastrophic crash in livestock numbers in the early 1930s as a consequence (see **Figure 4**).

COLLECTIVIZED INDUSTRIAL NOMADISM: MOBILE LIVESTOCK HUSBANDRY AGAIN ENCOURAGED

During the attempt to formally sedentarise Kazakh nomads from the 1920s, the loss of nomadic mobility meant the collapse of social relationships in practicing the seasonal migrations with livestock (Kindler, 2018). But by the mid 1930s, Soviet policymakers de-emphasized sedentism after witnessing the catastrophic effects of initial enforced reduction in livestock mobility and restriction to the collective farms, as "Nomadic practices, they discovered, allowed large-scale livestock rearing in the steppe. The Bolsheviks began to rely on what they formerly rejected" (ibid.).

While historians have concentrated their attention on the most dramatic disruptions to Kazakh nomadic husbandry over the last 100 years—forced collectivization and the famine that resulted in the early 1930s—after the middle of the last century, from the early 1940s to the late 1980s, there was a re-emergence of long-distance nomadic livestock management (Alimaev and Behnke, 2008; Robinson et al., 2016). At the beginning of World War II, an official USSR decree re-instituted migratory pasture use, "to organize distant pasture management... establish



livestock movement tracks for accessing distant pastures, Organize stopping points along these routes ... provided with water and ... fodder” etc. (cited in Alimaev and Behnke, 2008, p. 178). Several reasons led to this volte-face; the Kazakh nomads had been largely pacified after the brutal collectivisation effort of the 1930s and earlier repression of uprisings at the turn of the 20thC (Olcott, 1995). Secondly, technical appraisals of the costs and returns to sedentary livestock management in the collective farms concluded that it was more efficient to allow animals to graze natural pastures when and where possible, thereby increasing livestock output at less cost (Zalsman, 1948, cited in Alimaev and Behnke, 2008). Thirdly, Soviet scientists undertook close analyses to gain a clearer appreciation of the Kazakh nomads’ knowledge of seasonal pasture usages and livestock responses. Lastly, engineering and scientific advances under the Soviets generated new technology: to supply stock water; to irrigate feed crops; to develop new livestock breeds; to precisely assess natural pasture productivity; to calculate stocking rates and finally to dictate seasonal stock movement schedules aligned to optimal pasture nutritive values at different times and places (Asanov and Alimaev, 1990; Zhambakin, 1995). What had been created was in essence, a form of industrialized nomadism, in which the latest modern technical assets were coupled with ancient pastoralist skills, to adapt to and exploit the variable environment of Kazakhstan’s pasture wealth. This was a true marriage between Soviet obsession with modernization—electrification and heavy machinery—and Kazakh nomadic practice, sanctioned by Soviet scientists and driven by wartime pragmatism in WW2.

As early as 1935, for example, the practice of *otgon (ru.)* (or “remotely driven”) pastoralism was permitted within the collective farm system (Werner, 1997). Although *otgon* pastoralism entailed the seasonal migration of livestock

to different pastures beyond the collective farm boundary territories, the national authorities organized this very differently from the previous clan-based nomadic or transhumant pastoralism when a larger kinship group (the *aul*) migrated seasonally. In the newly-devised state livestock farms, small groups of employed shepherd families migrated to designated sequence of pastures with the state-owned flocks and herds.

Replacing the former “clan”-based livestock production system demanded new technical inputs, while traditional nomadic herding knowledge had to be activated through collective wage labor. The destruction of the old nomadic social order achieved in the earlier part of the 20th C left Kazakh families atomized, unable to manage large flocks or herds without extended kin. The upheavals of the 1930s had dislocated many Kazakh clan associations, as many families had died or emigrated to Persia or Chinese Turkestan; amongst those remaining in Kazakhstan, the collectivization process, and dekulakization had pulled larger kinship-oriented groups apart and segregated them into isolated settlements scattered across the rangelands. The scale of mobile livestock management was not feasible by individual families.

By the time USSR policy in the 1940s dictated that livestock management should return to more pasture-based seasonally-mobile nomadism, the social keystone for nomadic movement—the broader labor unit of an *aul* based on a patrilineage—had vanished. In its place was designed the brigade system, in which all collective farm labor was formally divided into group specializations such as: agricultural machinery (e.g., harvesters, tractors, trucks); veterinary; engineers for wells, irrigation systems and dams; accountants; and crucially, shepherding groups in charge of each livestock species and reproductive categories such as mating, lambing, calving etc. Collective farm families in these newly-settled villages received a salary plus

housing, and schooling and other social services including shops, medical facilities and pensions were provided. These new large state-managed farms gave rise to a new rural elite based on administrative control—the directors and technical staff of collective farms—and formally-educated professional status, rather than an elite based on personal livestock wealth and social prestige, as had been held by the *bailar*, who had either fled or been liquidated (Olcott, 1981).

The role of Kazakh women in livestock farming during the Soviet era was problematic. Women's emancipation and higher education was emphasized in the Communist ideology and some village women became teachers, accountants, nurses etc. At the same time, female fertility was officially promoted, e.g., with the "Order of Maternal Glory" awards for having many children. The state's provision of childcare and other social services was a buffer, but it appears that women did not abandon their pre-Soviet roles regarding daily tasks tending their family's own small flocks of animals that were permitted in the Soviet era (McGuire, 2017).

As the Kazakhstan national flock grew in the new collective farms, pressure mounted from central planners in Moscow to continually increase livestock output—herd numbers and amount of meat, wool and dairy products—to supply other parts of the Soviet Union with meat and wool (Asanov and Alimaev, 1990). This was achieved by intensification through cultivating more fodder crops with irrigation, and building new state livestock farms in more arid and less productive rangelands (Asanov and Alimaev, 1990; Gilmanov, 1996). The shift was completed by the mid 1960s, as large livestock farming settlements, complete with electricity, high schools, hospitals, and even theaters, were established in the semi-desert, while long-distance livestock movement covering many hundreds of kilometers was still undertaken using the brigade system. Livestock populations steadily grew from this point up until the crash after 1991 (see **Figure 4**).

ENVIRONMENTAL IMPACTS OF CHANGES IN LIVESTOCK MANAGEMENT DURING THE SOVIET ERA

The Soviet system of planned migrations was explicitly based on estimations of vegetation productivity, edibility and carrying capacity—which were mapped in great detail across Kazakhstan. Movements, grazing periods and supplementary feeding were planned with the dual objectives of maximizing production within environmental limits. However, in the 1960s the state attempted to intensify production in arid and semi-arid areas by increasing stocking numbers, extensive well-construction and reducing long-distance mobility, and it was at this point that the environmental impact began to worsen (Asanov and Alimaev, 1990).

The creation of 155 specialized sheep-raising *sovkhoses* on state reserve land, each with a stock of 50,000–60,000 sheep, blocked northwards migrations and forced state farms sited further south to spend more time grazing livestock on what had previously been only used as autumn and spring pastures. The vegetation was unable to develop and seed, reducing

yields to almost half of what is ecologically possible and led to soil degradation across large areas (Zonov, 1974; Asanov and Alimaev, 1990; Zhambakin, 1995). These problems were compounded by the plowing up of the best summer pastures in the 1950s, which increased reliance on the semi-arid pastures. As animal numbers expanded, herding labor and feed supplies were not the constraint to herd growth, but the natural pasture zones became over-used as seasonal pasture use "came under increasing pressure as all available grazing niches were occupied" (Alimaev and Behnke, 2008, p. 167).

Land degradation toward the end of the Soviet period was mapped according to anthropogenic desertification (Babaev and Orlovsky, 1985), but covering only arid and semi-arid regions of Kazakhstan. By the end of the Soviet period almost 60% of the area of arid and semi-arid Kazakhstan was affected (Kharin and Kiril'tseva, 1988; Babaeva, 1999), principally degradation of vegetation cover covering 44% of arid lands (Kharin et al., 1986). These authors blamed livestock production as the chief cause. But not all the area was severely affected; for example moderate degradation "involves the presence of more or less stable associations that have been productive for long periods but still include weed species" (Kharin et al., 1986, p. 63). Most moderately and severely degraded areas were to be found on sandy soil and livestock wintering areas. Dzhanpeisov et al. (1990) and Babaev and Kharin (1991) note that pastures on sandy soil, such as the Moynkum desert, are often severely degraded due to density of infrastructure such as cattle trails, winter camps, watering places, and shearing and dipping stations, created by the large-scale state livestock farms since the 1940s.

DESTRUCTION OF COLLECTIVE LIVESTOCK FARMS AND RISE OF PRIVATE OWNERSHIP AFTER THE USSR

The complex and costly apparatus of the state livestock farms rapidly began to disintegrate after the end of the USSR in 1991. By the mid 1990s, loss of the USSR-wide markets, currency devaluation, and farm debts forced most livestock *sovkhos* in Kazakhstan into bankruptcy; farm assets including livestock were officially privatized (World Bank, 1993). One of the cornerstones of the *sovkhos* system of livestock production had been the provision of high-quality winter fodder and feed supplements, sometimes imported from as far away as Ukraine. Intensive winter feeding had allowed steady growth of the livestock population (see **Figure 4**) to meet the central planning orders, but to the point where some ecological zones were experiencing pasture degradation, as noted above (Asanov et al., 1992; Ellis and Lee, 2003). This was the setting for the complete transformation of the former production and land use system.

The dismantling of state and collective farms was largely completed by 2000. This process and its evolving effects were documented in a series of field research projects in south central Kazakhstan between 1997 to 2015, summarized here.

Privatization of the state farms was implemented hurriedly under duress, by state officials in shock and with incentives provided by the Western financial agencies i.e., World Bank,

International Bank for Reconstruction and Development, and International Monetary Fund (Spoor and Visser, 2001). Not surprisingly, privatization had deep and very damaging structural impacts. Nearly all the physical inputs necessary for seasonal livestock movement disappeared—heavy transport, fuel, housing etc. (Behnke, 2003; Robinson and Milner-Gulland, 2003a; Kerven et al., 2004). The state no longer provided winter fodder for animals, while irrigated or rainfed land previously used for fodder crops was converted to higher-priority food and cash crops. State farm workers lost their jobs, wages and social security benefits. Individual rural families had to work out how they were going to raise livestock without any external assistance in the form of government inputs, subsidies, or technical advice from professionals. Most ex-farm employees were in a state of shock and sought only to survive, mainly by bartering and slaughtering whatever livestock they had managed to obtain from their former state farm employers.

By the time the USSR ended, there was surplus rural labor required for livestock production (Ellman, 1988; Lerman et al., 2002). In Kazakhstan, as livestock numbers crashed due to the end of subsidies and economic chaos (see **Figure 4**) there was a rural exodus to seek work and incomes in urban areas, as agricultural households experienced greater poverty (Behnke, 2003; Spoor, 2007). Remaining behind were smaller family units, as women had fewer children, rural child mortality rates increased (UNICEF, 2006) and adult children increasingly left the villages for higher education or work in towns (Pomfret, 2003; McGuire, 2013), rejecting the conditions of village work with livestock. The rural demographic pattern changed to an older age structure, leaving a shortage of younger family labor for the strenuous work of livestock production. In the absence of sufficient family labor, household flocks had to be entrusted to shared local labor or casual itinerant laborers, who might have little previous experience of herding. Many livestock were simply slaughtered for local consumption or sold to quickly-developing private markets for barter or cash to pay debts and buy food (Kerven, 2003; Kerven et al., 2004). New informal markets were flooded with supplies of livestock, causing prices to collapse which obliged people to sell still more livestock to buy food and other necessities. The few remaining livestock formed tiny flocks for newly-impoorished villagers who lacked other resources or income (Kerven et al., 2004). Traveling with livestock in mobile flocks became much more risky and costly for most rural families, due to greatly diminished economies of scale.

Concomitant with this reversal of labor conditions after 1991, the capital-heavy technology supplied and maintained by USSR subsidies for state farm use was abandoned, wrecked, appropriated, or melted down and sold to Chinese buyers. Irrigation pipes were smashed and not repaired. Mechanical pumps were stolen or effectively privatized on former communally-used wells when pasture land was allowed to be privately leased (Behnke, 2003; Kerven et al., 2004). Heavy machinery such as harvesters for fodder and trucks for livestock transport was similarly taken out of communal farm and transferred to private property. Only a few individuals perceived the opportunity to garner these valuable capital assets in the prevailing chaos. These individuals were typically members

of the Soviet farm professional elite—with tertiary education as veterinarians, accountants, agricultural engineers or animal husbandry specialists—who had managed the state farms and largely inherited the assets of the defunct farms (Behnke, 2003). In the process of dismantling state farms, members of this elite were in a position to appropriate much of these farms' capital equipment and infrastructure. Through their acquisition of key inputs, the elites were able to achieve the economy of scale needed for mobile livestock management as “Lumpiness or fixity of assets is one of the main factors contributing to economies of scale” (Lerman et al., 2002, p. 46).

NOT ALL PEOPLE ARE EQUAL: BESHBARMAK “FIVE FINGERS ARE NOT EQUAL.”

In a remote desert garage on the trunk road from Almaty to Moscow, 7 years after the collapse of the USSR in 1991, a former state-employed mechanic had accumulated 100 cattle, 200 sheep, 40 horses, and 15 pigs. He asserted:

“My grandfather was a *bai*, a very wealthy man. In 1928 their livestock were taken by the government. These days, now, people are learning. In the past, Kazakhs could maintain their animals by moving and never used to be commercial... Firstly, pastoralists need land, private land—need 100,000 ha for one family. I would not want to fence this land, as before people divided up the land without fencing. There would be enough [range] land for those who want. On this land I would bring workers who would have jobs and I would not have to sell my wool to Chinese traders at such a cheap price. No one should prevent me from working as I want on the land. My grandfather had a lot of private land and he knew what to do with this land. *Beshbarmak* “five fingers are not equal.”² (Kerven et al., 1996, field notes).

Farm privatization was allowed to proceed with little or no intervention from the state, leading to large-scale inequities in the distribution of state material, landed resources and livestock (Behnke, 2003; Dudwick et al., 2005; Robinson et al., 2012). The maldistribution of former collective farm assets meant the appearance of a new minority group of large-scale livestock owners who had distinctive social and economic attributes initially noted in a two-year survey of sheep-owning households in the rangelands of south-central Kazakhstan (Kerven et al., 2004, 2006; Milner-Gulland et al., 2006). Successive government policies and laws allowed these large-scale livestock owners to register leasehold title over former state farm pasture land containing key resources such as water points, barns, hayland or winter houses in the seasonal grazing areas. They had bought or appropriated discarded heavy transport Soviet vehicles that allow them to support their animals and hired herders in remote grazing areas and to take animals to distant urban markets for better prices. As the national economy was bolstered after 2000 by oil and gas extraction, growing urban incomes increased demand

²Literally “5 fingers” referring to the national celebratory meat dish of Kazakhs and Central Asians, traditionally eaten by hand using 5 fingers.

for meat (Pomfret, 2009), which meant that raising livestock for a commercial market became even more attractive for those who could seize the opportunities (Kerven, 2003). Being able to profit from these markets led to further accumulation of livestock and capital investment into their livestock enterprises. They quickly developed a commercial rather than subsistence approach to livestock marketing, selling fattened male adult animals in urban markets at seasons when prices were highest (Kerven, 2003). Livestock wealth has tended to accrue largely to these owners, widening the disparity with flock and herd sizes of the majority of owners (Kerven et al., 2016a).

The large-scale owners typically have certain social characteristics in addition to having initially acquired the material assets needed for managing large flocks (Kerven et al., 2016a). They deploy extended kinship networks in both their village and cities to combine access to crucial resources of rural infrastructure (barns, houses, wells), arable or hay land, family labor for flock management and financial credit. The large-scale livestock owning farms are usually multi-generation patrilineal family units, consisting of a father and several older sons, or several brothers and male cousins working together. Similar patterns are recorded by McGuire (2013, p. 35), who remarks on the resemblance to pre-Soviet interdependencies between shepherding labor, livestock numbers and social differentiation: “Families have surmounted the challenges posed by a lack of sheep or a need for sheep husbandry by fashioning collectives that stitch together the land, labor, and flocks of multiple disparate households. Extended networks of kin band together to create flocks, and poor households ensure access to land—and perhaps their own future flocks—by trading labor for sustenance and a share of the flock’s live offspring.”

The big sheep owners initially in the early 2000s often hired herders, who were indigent (homeless) non-ethnic citizens or impoverished people from neighboring Kyrgyzstan or Uzbekistan willing to work in remote locations for their keep only, in the early 2000s. But a decade later, as being a big livestock farmer became more lucrative, sons or brothers of the bigger flock owners were assigned to supervise the workers while the livestock owners—heads of their families—based themselves in comfortable village homes or even in provincial towns and cities. The owners make livestock management decisions as semi-absentees by visiting their flocks regularly to check up and bring supplies.

Shepherding remains a gendered task as in the recorded past, since men accompany the sheep and goats, on horseback if possible, throughout the grazing day due to predators (jackals and wolves). Horses, cattle, and camels can be left to graze unaccompanied nearby villages or camps, but must be led by men out and back from pastures. Women and older children may be responsible for putting livestock into barns, giving them fodder, and tending young animals, as well as milking cows and horses, and sometimes goats.

With regards to changes in gender roles in managing livestock, there is remarkably little ethnographic or quantitative material. Efficient management of private large flocks requires shepherding labor to undertake seasonal movements, and this requires feeding the shepherds. One recent analysis in southern

Kazakhstan (McGuire, 2017) notes the social tension arising from “the necessity of women’s domestic labor to the operation of a herding camp” creating new economic ties between households, through marriages intended to support shepherding (McGuire, 2017, p. 121).

The amalgamation of rising prices for meat, new sources of investment capital, new government policies after 2003 all “stimulated the revival of livestock farming” (Pomfret, 2009, p. 35), and encouraged private leasing of pastureland by bigger stock owners. There is a rising wealthy class of livestock producer—the new *bailar*. Their most significant difference with smaller livestock owners’ method of production is their return of long-distance migrations to seasonal pastures (Kerven et al., 2006, 2016a,b). These men explicitly refer to the past, in planning their future.

The new big flock owners are not apologetic. They assert that they are either restoring an old order of control exercised by their ancestors, when they can claim descent from *bailar*, or to be embracing the new market economy which is encouraged by the national government. In contrast to the social position of *bailar* prior to the repression of the 1930s, the new livestock elite do not consider that they have any social, political or economic obligations toward the wider communities within which they reside. These new *bailar* are modern men who equate themselves to Australian or American ranchers. They seek imported high-yielding exotic breeds of livestock, market their animals very efficiently by fattening before selling and waiting to sell in seasons when prices are highest, invest in new technology and refer to their grazing outposts as “*fazenda*,” (ranch in Portuguese) learned from watching a popular TV soap opera about ranchers in Brazil (Kerven et al., 2016a). The new big livestock owners are, in effect, open-range ranchers.

PASSIVE AND ACTIVE IMPACTS OF GOVERNMENT PROGRAMMES

For nearly a decade after independence in 1991, the state paid little attention to the livestock sector on the rangelands, being preoccupied with profiting from development of the enormous reserves of oil and gas within these rangelands (Pomfret, 2009). The formal role of the new local and national government after independence in 1991 was limited to new pastureland tenure regulations (Robinson et al., 2012), much of which were misinterpreted or circumvented by livestock owners in practice (Behnke, 2003; Kerven et al., 2006). The livestock sector therefore evolved in an unregulated vacuum of central power and under the control of local privileged elites, survivors from the Soviet period in the chaotic early transition period.

In the last few years, the Kazakh government has issued laws and programmes that appear to support large-scale livestock owners and ignore the mass of small-scale owners (World Bank, 2019a; Robinson, 2020). A vast subsidy programme between 2017 and 2021, currently over 90 million USD, created subsidies for registered farmers but only the largest farmers who meet herd size and land area conditionalities received

these subsidies. The subsidy funds were principally intended to promote intensification, through improved feeding, animal housing, using imported pedigree stock, and ranching-style management (Robinson, 2020). There are approximately 200,000 registered farms and a very small number of quasi-government livestock enterprises, mainly specialized breed farms (*ibid.*). In comparison, there are 1.6 million rural households, who collectively own nearly two thirds of the nation's livestock, but whom have not benefitted from the government subsidies. These small-scale household farmers have on average 2 cattle and 7 sheep or goats, while the mean for the 200,000 registered private farms is 11 cattle and 34 small stock (*ibid.*). The size of livestock holdings is highly stratified between and within these official categories of farms, as illustrated in **Figures 5A,B**, from two case studies carried out from 2011 to 2015 in the Moiyunkum semi-arid region of south central Kazakhstan (see Kerven et al., 2016b; Robinson et al., 2017) and three wetter districts of Almaty Province in 2018 (Robinson, 2020). Nationally, the village households who comprise nearly 90% of all livestock owning units, have much smaller flocks and herds than the small group of private registered farmers and enterprises (**Figures 6A,B**).

A recent World Bank (2018) review of Kazakhstan's agricultural programme recommends shifting subsidies to promote productivity, growth, and environmental sustainability, explicitly recognizing that extensive livestock management can be more environmentally sustainable than greater reliance on cultivated fodder crops and reduced natural grazing. New subsidy packages and messages are currently being planned by the World Bank together with the Kazakh government, in the Kazakhstan Sustainable Livestock Development Project, 2020–2024 (World Bank, 2019b). Apparently, the Kazakh government is shifting the focus of state support to small and medium farmers—but only cattle farmers—and away from the sole focus on large agri-enterprises. The new subsidy project is targeting medium farmers having 10–50 head of cattle, as well as large registered farmers and enterprises with up to several thousand head of cattle.

There are contradictory signals from the government and external agencies. On the one hand, generous subsidy and advisory packages are targeted at the larger herd and flock owners, who may already be practicing seasonal livestock mobility, while on the other hand, programmes are promoting intensification of livestock feeding by growing more feed crops. Although most of these government subsidies have promoted sedentary farming and intensification, funds targeted for water point and winter house rehabilitation (Robinson, 2020) also indicates a policy to promote distant pasture use. Nevertheless, at present the indications are that only those registered farmers with larger flocks or herds are entitled to benefit from these government promotions.

There is yet very little practical support to the preponderance of Kazakhstan's livestock owners, who individually own only a few animals and therefore cannot access distant pastures as their livestock holdings are too small.

Pastoral Scale and Livestock Mobility

Considering the past on the Kazakh rangelands gives us a window for speculating about some potential trends for the near future. Will pastoral mobility decline further; will more pastoralists return to mobile livestock management; what are the attractions and disincentives for these choices; and what could be the most effective forms of grazing land management for the environment and for human welfare?

The Kazakh government considers the mostly sedentary village-based livestock farmers to be economically unviable and their animals a threat to the grazing land around villages, which has become overgrazed since the end of the USSR (Ellis and Lee, 2003; Alimaev et al., 2008; Dara et al., 2020). The circum-village overgrazing is due to small-scale livestock owners being usually unable to seasonally migrate to distant pastures—either hundreds of km across the desert and steppe plains, or vertically up steep mountain tracks—due to the cost of transport, unavailability of labor, badly maintained roads, and bridges etc. (Kerven et al., 2004, 2006, 2008, 2016b; Hauck et al., 2016; Ferret, 2018; Robinson, 2020). Nevertheless, in better-favored locations nearer to cities with high demand for livestock products of meat and dairy, it has been economically viable for a minority of small-scale livestock owners to continue vertical transhumance from valleys and plains in winter to high summer mountain pastures in summer, using spring and autumn pastures in the foothills, with several hybrid forms of social organization (McGuire, 2013; Hauck et al., 2016; Ferret, 2018). Those small livestock owners who send their animals away to graze for the summer are likely to do so by grouping animals with those of larger livestock owners while wealthier families with more livestock hire their own private shepherds to tend their flock for the summer mountain period.

Although the majority of Kazakhstan's livestock are owned by small-scale farmers, they can only legally access 12% of pasture area, which is immediately around villages, compared to the minority of registered farms which have so far leased double this amount of pasture (Robinson, 2020). A further half of the nation's pastureland, much of which is theoretically available for lease, still remains under direct central state control. This state land can be used for grazing, either informally or with official permits. Nevertheless, this state pastureland is typically quite remote from settled villages, which reduces the chance for small-scale livestock owners to seasonally move their livestock for grazing away from the villages. Meanwhile, small-scale livestock owners are increasingly excluded from the more productive pastures which being more distant, also have lower grazing pressure and accessible ground water, and have already been privatized either *de facto* or *de jure* (Kerven et al., 2016a,b; Robinson et al., 2017). After decades of stasis, long distance migration and short distance transhumance are re-appearing, but only for the larger flocks. Larger herd owners in the post-Soviet era can take advantage of economies of scale by reducing their production costs per livestock head taken on long-distance migrations (Robinson and Milner-Gulland, 2003a; Kerven et al., 2004, 2006). At the same time, formerly mobile pastoralists have become mainly

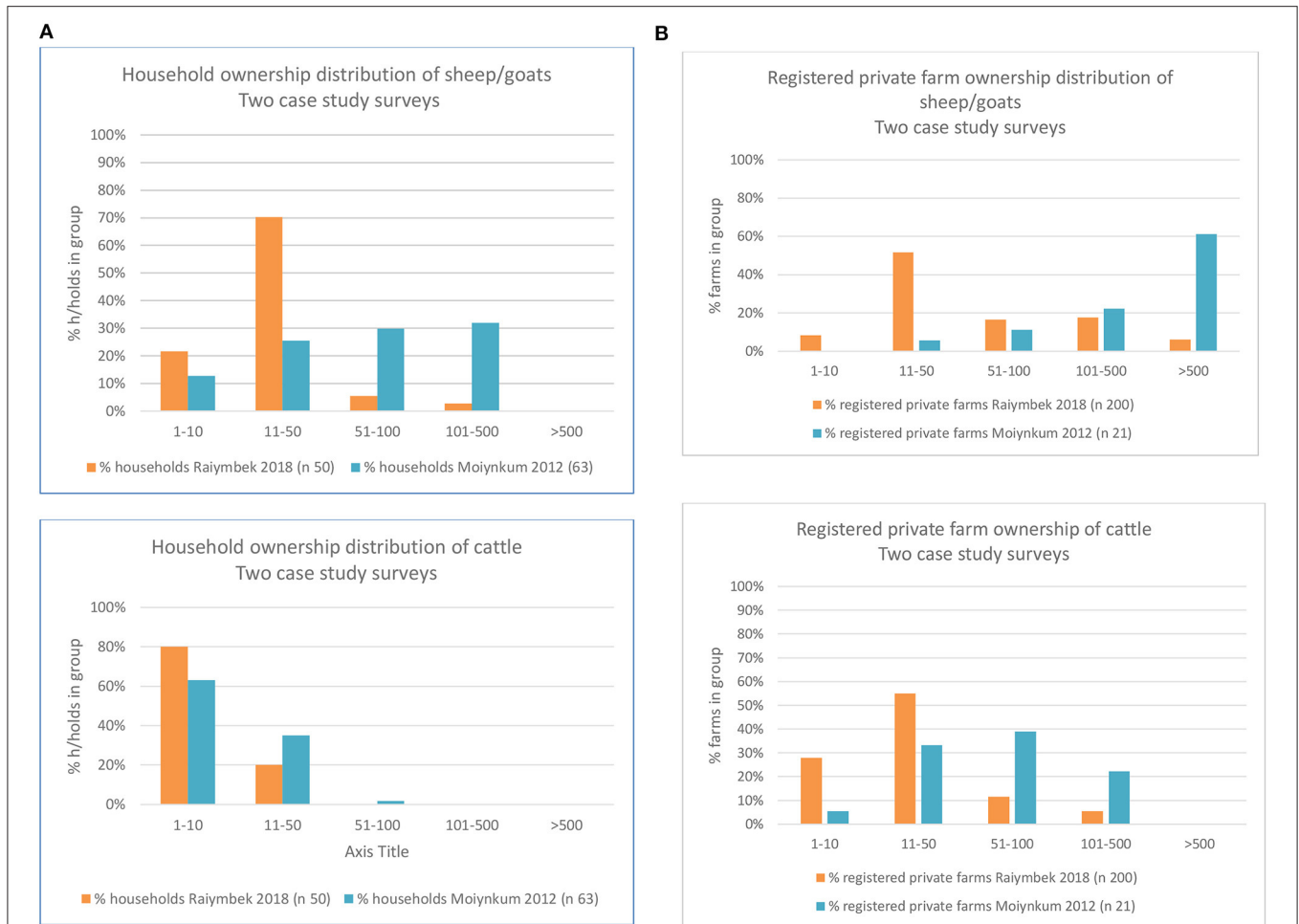


FIGURE 5 | Current livestock distributions by households and registered private farms, from two case studies in southeastern Kazakhstan 2012 and 2018. **(A)** Households (unregistered). **(B)** Registered private farms. Sources: For Raiymbek case study, "Revitalizing animal husbandry in Central Asia: A five- country analysis, funded by the German Federal Ministry of Education and Research" (Robinson, 2020). For Moiynkum case study, data from "Mobility versus Exclusion: Limits to Ideal Free Distributions in Pastoralist Systems," Leverhulme Trust to Imperial College London 2011–2014 (Kerven et al., 2016b; Robinson et al., 2017).

sedentarised, by being unable to afford seasonal movement and being effectively excluded from government subsidy and credit programmes or through family choices of alternative livelihoods (ibid.).

A Century of Change in Kazakhstan's Livestock Holdings

Figure 7A indicates that a century ago, Kazakh livestock-owning units had much higher mean numbers of livestock—nearly 4 times more sheep, twice as many cattle, 5 times more goats, 7 times more horses and 20 times more camels, compared to the mean of private farms and households owning livestock at the present. There are now nearly the same national number of sheep and cattle as recorded in 1913, but these are currently distributed between 1.9 million livestock-owning units compared to less than half a million a 100 years ago (Kazakh Academy of Sciences, 1980; Kazakhstan National Statistical Agency, 2018). The national proportions of sheep and cattle are remarkably

similar in the past and present, as shown in Figure 7B—but there are now fewer horses and camels previously required for transport.

Environmental Impacts of Livestock Management in the Post-soviet Period

There are undoubtedly environmental consequences of these recent recorded changes in land use and livestock management. If the rangelands of Kazakhstan are partly the product of livestock grazing over millennia, can effects be discerned of the most recent changes happening in the last decades? What changes can be anticipated in the near future?

Several kinds of environmental changes in the current and former grazed rangelands have been quite closely monitored since the collapse of state-managed livestock and crop farming in the early 1990s. Firstly, field analyses have been carried out on the several different types of vegetation successions occurring

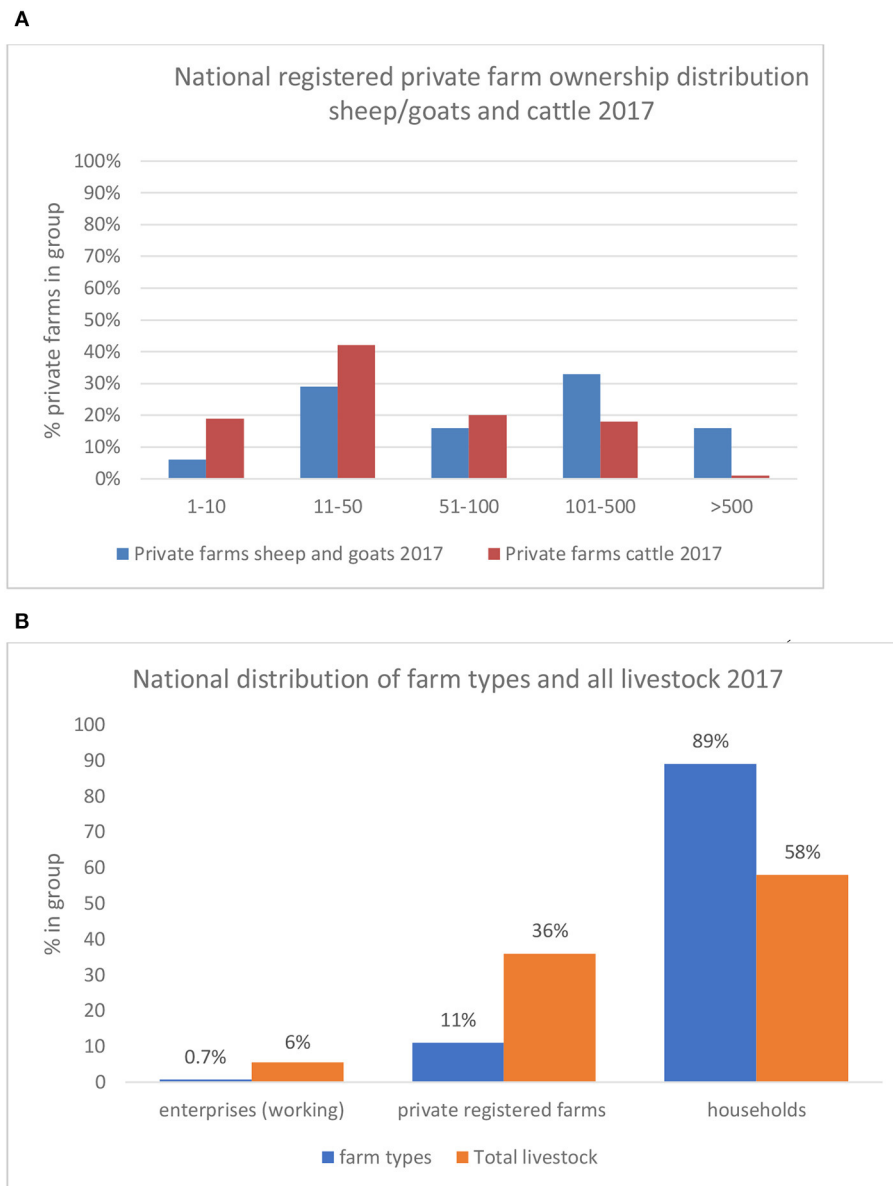


FIGURE 6 | National livestock ownership distribution 2017. **(A)** Registered private farms sheep/goats and cattle. Source: Kazakh National Statistical Agency 2018. **(B)** All livestock (sheep, goats, cattle, horses, and camels) by farm type 2017.

with the rapid and radical changes in land use since 1991. Land on large state farms which was cropped for many decades before the 1990s has been abandoned and is returning to rangeland. In another process, land that was formerly grazed for many decades is now only being lightly grazed or not at all. Secondly, there have been investigations of how land use changes have affected carbon sequestration in plants and soil, mainly due to abandonment of cropping in the former Virgin Lands region of northern Kazakhstan and some return of livestock grazing (Perez-Quezada et al., 2010; Kurganova et al., 2015; Schierhorn et al., 2019). Thirdly, there are studies on the biodiversity

implications of the radically altered livestock grazing pressure patterns and crop cessation (Kamp et al., 2009, 2011, 2015, 2016). Together, these changes over the last three decades point to the substantial effects of different livestock grazing intensities on the ecology and sustainability of the Kazakh rangelands for the future.

Rangeland Vegetation Transformations

As rainfed cropping sharply declined with the absence of state support after the end of the USSR, by 2000 about 40% of arable land in Kazakhstan had been withdrawn from cropping

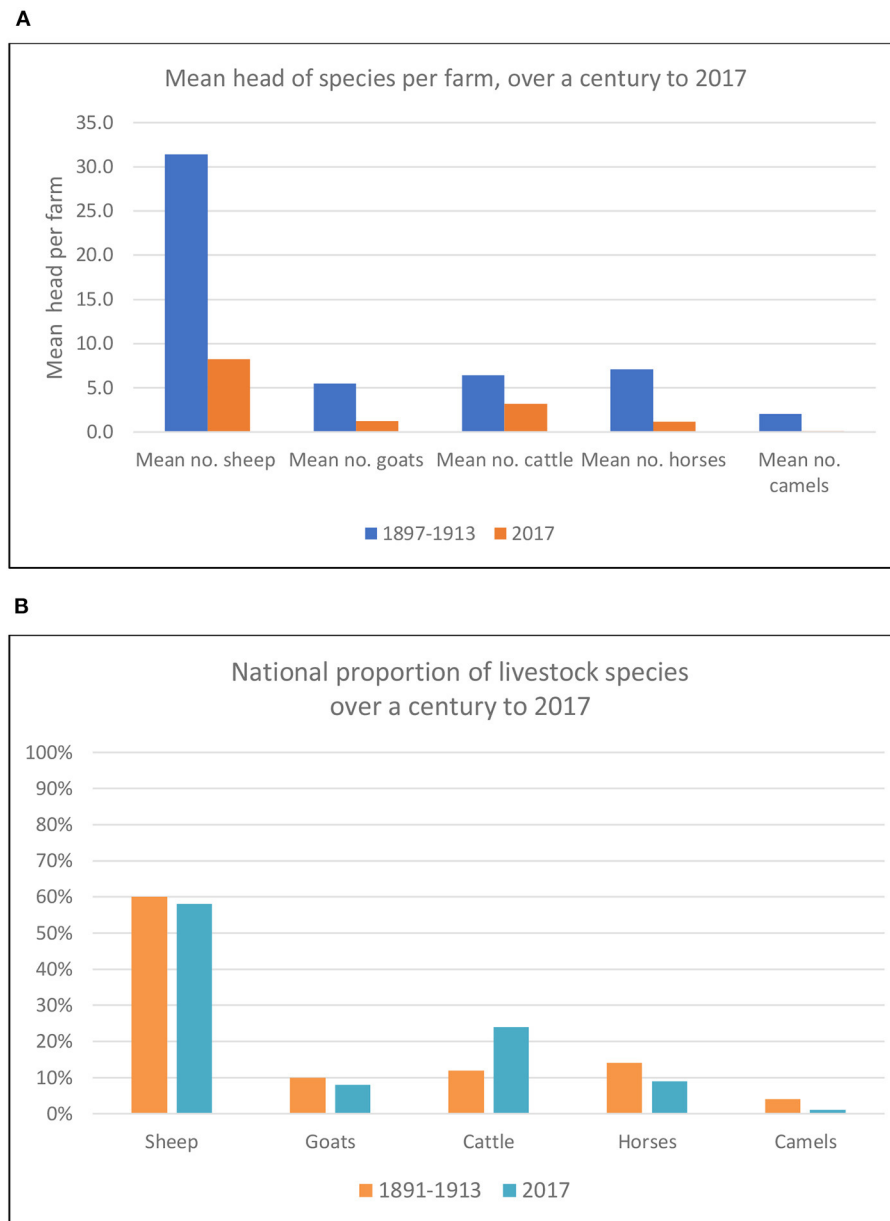


FIGURE 7 | A century of change in Kazakhstan's livestock holdings. **(A)** Changes in livestock holdings per farm in Kazakhstan. Total number of households in 1897/1913 was 582,587 (nearly all rural). In 2017 total private registered farms and households (excluding large commercial enterprises) was 1,832,248. **(B)** Changes in the species of livestock kept in Kazakhstan. Sources: (Kazakh Academy of Sciences, 1980; Kazakhstan National Statistical Agency, 2018).

over two decades (Kamp et al., 2011; Dara et al., 2020). Some 14.1 Mha of abandoned crop land remains uncultivated (Schierhorn et al., 2019). Over the same period, as has been discussed here, livestock numbers crashed, most of the remaining livestock could not be taken to remote pastures, and instead had to be grazed around villages (Behnke, 2003; Robinson and Milner-Gulland, 2003b; Robinson et al., 2016). This second process has led to a mosaic of heavily grazed and ungrazed or lightly grazed rangeland zones, with consequent ecological impacts.

One detailed study (Brinkert et al., 2016) examined the changes in vegetation diversity resulting from these combined processes of spontaneous succession of the abandoned crop land and the loss by the late 20th C of both domestic and wild ungulate grazers, the latter mainly *Saiga tatarica* antelope. The study compared plant succession and soil conditions in grazed and ungrazed abandoned crop fields and “near-natural” steppe, and found that grazing greatly hastened the return of these abandoned lands to steppe-type vegetation. The authors theorized that due to the effects of “pyric

herbivory,” “The interaction between free roaming grazers and fire promotes a moving patch mosaic at the landscape scale that favors biodiversity and pasture quality in grasslands. When grazing ceases completely, one essential component of this old evolutionary disturbance pattern gets lost which might have far-reaching consequences for biodiversity and ecosystem processes” (op. cit. p. 2557–2558). Dara et al. (2019) demonstrated through remote sensing that the decrease in grazing pressure in northern Kazakhstan was associated with increased fire prevalence due to accumulation of dry vegetation, with attendant risks of reduced biodiversity. Brinkert et al. conclude quite firmly that “grazing is mandatory to fully restore the original near-natural steppe vegetation and the underlying processes of pyric herbivory” (op. cit. p. 2,544). Hence, we might reasonably assume that “near-natural pastures” are not pristine but instead are evidence that different degrees of biodiversity result from more or less grazing by large wild and domesticated herbivores over thousands of years. “Natural” is therefore difficult to pinpoint.

Larks and Lapwings in the Rangeland

Small bird species, some critically endangered on the IUCN Red List, as well as small mammals and insects, have been closely studied in the contemporary Kazakh rangelands; for example, the Black Lark *Melanocorypha yeltoniensis* (Lameris et al., 2016), White Lark *Alauda leucoptera* and the Sociable Lapwing *Vanellus gregarius* (Kamp et al., 2009, 2015). It transpires that the abundance and community composition of certain species varies depending on whether the sites are heavily-grazed, under-grazed, and in more or less proximity to human settlements (Kamp et al., 2015). The conclusion is that “Heterogeneity in grazing levels, including very heavy local grazing, seems to be crucial for species-rich steppe bird and mammal communities (Kamp et al., 2016, p. 2,530).

Carbon in the Rangelands

Studies from 10 years after the abandonment of state grain farms in the northern Kazakhstan steppe region (Perez-Quezada et al., 2010) found that carbon flux components of net ecosystem exchange were greatest in abandoned crop land, followed by “virgin land” which had not been used for crops (but probably would have been grazed by livestock at some point up to the early 20th C) and least for land sown with fodder crops, wheat or barley. Soil organic carbon was highest for the “virgin lands” and “decreased with greater degrees of cultivation” (ibid. p 91).

Grasslands store more carbon than arable soils because a greater part of the organic matter is physically and chemically stabilized (Soussana et al., 2010). Conversion of croplands back to grazing land results in carbon sequestration which may continue for many decades (McLauchlan et al., 2006). Schierhorn et al. (2019) find that since the end of the Soviet Union there was a large reduction in GHG emissions in the former USSR, including in Kazakhstan, much of which is due to carbon sequestration from abandonment of croplands and reduction of livestock. These soils still have carbon fixation potential because abandoned croplands hold less carbon than native grasslands (Causarano et al., 2011), which sequester additional carbon as vegetation succession proceeds (Perez-Quezada et al., 2010).

Ecologists, wildlife scientists and conservationists familiar with the effects of recent land use changes on the Kazakh rangelands have concluded that one of the main issues for the future is the current “undergrazing” of large areas, which affects how the ecosystem functions and increases fire risk. Restoring free-ranging livestock on the Kazakh steppes, coupled with management advice on ecologically sustainable stocking rates and the heterogeneity of grazing patterns, might result in conservation benefits (Kamp et al., 2016). This view is shared between widely disparate disciplines, in for example, the conclusion reached from archaeological research in Kazakhstan, that “As modern ecologists focus on the restoration or rewilding of grasslands through the re-introduction of wild species to increase biodiversity, a secondary discussion should focus on how animal husbandry might also contribute to grassland ecology” (Ventresca Miller et al., 2020b, p. 11).

DISCUSSION AND CONCLUSIONS

When considering the human impact on rangelands, a key question is what do we mean by “natural”? (Miehe et al., 2014, p. 190). The rangelands of Kazakhstan have been partly shaped by pastoralists’ livestock, in addition to being molded by forces of past climate change, wildlife, erosion and deposition, amongst other forces. Therefore, at what point in the past do we demarcate these landscapes as “natural” in the sense of pristine and unchanged by people? A growing body of interdisciplinary literature—combining archaeology with natural and social sciences—refers to these human-environment interactions as “the pastoral niche construction” (Lezama-Núñez et al., 2018) and “ecosystem engineering” (Ventresca Miller et al., 2020b). What does this mean for the future of livestock management and the environment on the rangelands?

The influence of pastoral nomadism on the formation and dynamics of rangeland environments in Eurasia is comparable to that of the East African savannahs as far back as 4,000 years ago (Marshall et al., 2018). Similarly, pastoralism has shaped the high grass plateaus of Asia over millennia (Miehe et al., 2014), and in historic times the pampas of South America (Modernel et al., 2015) and grasslands of Europe (Benthien et al., 2018). To consider the present and near-future impacts of livestock on rangelands, we need to adjust the length of our focus to a long time scale into the pre-historic past—to take “*the longue durée*” (Braudel and Wallerstein, 2009).

Large-scale livestock movement in the Eurasian climate and environment has only been possible with large flock/herd sizes. This scale of collectively-managed animals has been made possible through three “modes of production”—kinship-based, state, and capitalist. Humans have shaped the landscape and ecology of what has, latterly, been defined as a natural environment. The history of the Kazakh pastures reveals how in order to preserve the natural, we have to create the social conditions for collectively managed mobile livestock. These conditions are currently imperiled by administrative and economic constraints facing small-scale rural households.



FIGURE 8 | (A) New ground water pump and livestock drinking troughs installed by owner with several thousand head of livestock, Moynkum region, south central Kazakhstan, 2014. Photo: Carol Kerven. **(B)** Soviet era shepherds' wagon and motorbike, with new 4X4 truck belonging to large-scale "fazenda" Kazakh rancher in Moynkum region, south central Kazakhstan, 2015. Photo: Carol Kerven.

Kinship-based nomadic pastoralism up until the beginning of the 20th century underpinned the mobile exploitation of pastures that were seasonally, annually, and geographically variable across an enormous territory that required military vigilance. In the Tsarist period, use of the extensive scale of heterogenous and wide-open spaces required a social scale larger than that of an individual family, for sharing herding labor requirements and defense against incursions. Consolidation of Tsarist and then Soviet authority over the territory then obviated indigenous political groups' need for defense from other groups. Following a devastating hiatus in the late 1920s and in the 1930s, the national and supranational state (USSR) then assumed administrative, technical, and financial responsibility for re-engineering long-distance seasonal livestock mobility. In these state livestock farms, specialist livestock management activities were assigned to a professionally-trained and centrally managed labor force supported by external capital and scientific research. The demise of central state obligations in the early 1990s initially left individual rural households bereft of necessary resources to resume seasonal livestock mobility. But rising national wealth, new laws and individual initiative has meant that a small proportion of livestock owners are again following some of the old nomadic trails, albeit with mobile telecommunications, hired herders and SUVs, bolstered by public and private financial investment from urban sources **Figure 8**.

In the contemporary period, narratives, and cultural symbols e.g., yurts, are used to reify Kazakhs' ethnic identity in a "cult of mobile pastoralism as national folk culture" (McGuire, 2013), appropriated by popular media, and proffered by some politicians and scholars as a unifying nationalistic theme (Schatz, 2004). However, in current times, "Should a shepherd abandon the steppe for the city, they would likely find themselves treated not as a cultural hero but as an impoverished and disregarded laborer" (McGuire, 2013, p. 26).

The 21st century brings new opportunities but also challenges for Kazakh rangeland management. At present, only a small minority of livestock owners can and do undertake long-distance seasonal migrations with their private livestock, for reasons outlined in this paper. We have argued here that maintenance of flock and herd mobility requires a level of labor inputs and capital goods, operating within structured social-economic and political institutions. The Soviet collective farm experiment demonstrated that new technology and capital infrastructure could substitute considerably for labor inputs. The picture at present is that individual wealthier livestock owners are replicating this pattern, through investment of private capital increasingly assisted by state and international capital. The impediment to increasing livestock mobility nationally is that the majority of livestock owners have herds and flocks that are too small to justify their individual investment in the technology (mainly heavy transport and developing water points) necessary for longer-distance livestock mobility (see **Figure 7A**). Many smaller livestock owners must continue to graze and fodder their livestock mostly around settlements, with severe environmental impacts.

Increasing the proportion of livestock feed supplied by farmed fodder in relation to grazing on pastures—has been a driving force since the 19th C under the Russian administration, followed under the Soviet state farms which invested capital into forming industrialized nomadism, highly subsidized by central USSR funding from Moscow, and now again with state subsidies targeted to the bigger livestock owners. In each instance, the aim was to stabilize productivity by introducing new sources of feed, while continuing to benefit from lower-cost feed by grazing the rangeland environment. The temptation to intensify is strong—to suppress variability and raise livestock output—but eventually there are social and environmental impacts, as reviewed here.

A fine-grained longitudinal analysis (1985–2017) over a large rangeland and farming region of northwestern Kazakhstan showed that "Recent increases in livestock numbers did not translate into major increases in grazed area, suggesting that the intensification of livestock systems, with feedlot-based livestock fed by crops, is playing an increasing role" (Dara et al., 2020, p. 11). Financial inducements—e.g., subsidies for growing feed crops—may shift larger producers' livestock management decisions, by tilting the balance of costs and returns away from mobile seasonal grazing. As an alternative, Kamp et al. (2015) recommend that instead of converting (or re-converting) pastureland to fodder crops, currently unused pastures might be accessed by livestock in the optimal seasons, which would allow "more transient grazing patterns (thereby creating a mosaic of different grazing intensities)" (ibid. p. 1,584).

Given that Kazakhstan still contains a large share of the world's remaining "near-natural" temperate grassland (Kamp et al., 2016), how the Kazakh steppes, adjacent deserts and mountains are managed has global implications for plant and animal biodiversity, carbon stocks, and at a national level for the well-being of Kazakhstan's people and the economy.

The question remains as to whether it will be possible for the majority of livestock owners in Kazakhstan, who also own most of the livestock, to regain the system of mobile livestock management which their ancestors practiced. Only a few are able to do this now. It seems that capitalism can only achieve the necessary scale of herding congruent with the environmental scale by concentrating resources on individuals and corporate groups. But this creates further inequality between herders based on their wealth status, and leads ultimately to environmental degradation, as those individual livestock keepers left behind are condemned to over-exploiting the narrower base of rangeland resources still at their disposal.

AUTHOR CONTRIBUTIONS

CK conceived the paper and prepared the first drafts. RB provided theoretical ideas and research experience among pastoral nomads, including in Kazakhstan. SR contributed new information and research findings from Kazakhstan. All authors have worked together on research in Central Asia over several decades.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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