Human Ecology
https://doi.org/10.1007/s10745-021-00287-0

# A Natural Disaster Framed Common Pool Resource Game Yields No Framing Effects Among Mongolian Pastoralists

**Thomas Conte**[1]

Accepted: 16 October 2021


**Abstract**
This study used common pool resource experimental economic games to explore the effects of natural disasters on Mongolian pastoralists' common pool resource management. In this game, two anonymous players have access to a hypothetical envelope of money from which they can withdraw funds. Three versions of the game were used: a version in which the amount of money players can withdraw is constant, one where the amount of money could change by chance, and a version where the amount could change because of a hypothetical natural disaster (*dzud* in Mongolian). The results indicate that framing the game as a natural disaster had no framing effects on players' behavior in two regions of Mongolia: one that is highly susceptible to winter weather disasters and one that is less susceptible. These results suggest that cultural norms and values regarding common pool resource use might prevent over-extraction in rural Mongolia.

**Keywords** Pastoralism · Common pool resources · Experimental games · Mongolia · Natural disasters

## Common Pool Resources: Economic and Management Implications

Common pool resources are too costly for individuals to exclusively manage or exclude access to and to which all users have simultaneous access (Ostrom, 1990). These include forest, grassland, and marine resources. Common pool resources are often too large to effectively police, and aggregate off-take by users decreases available resources and determines regeneration rates (Ostrom et al., 2002).

Social scientists have argued over the ecological and economic viability of long-term common pool resource management (Berkes, 2006). Hardin (1968) argues that common pool resource use inevitably leads to over-extraction because it is in each user's economic interest to maximize extraction at the expense of other users and the surrounding ecology. This is because a user gains economic benefit from over-extraction but incurs only a fraction of the net cost of over-exploiting the resource (Hardin, 1968).

In response to the potential tragedy of the commons in the Century, policymakers in nations with extensive common pool resources began to shift common ownership of resources towards privatization (Fratkin & Mearns, 2003; Li & Huntsinger, 2011). This management shift was based on the assumption that over-extraction could only be mitigated by incentivizing resource conservation by delineating ownership of resource patches. This attitude was particularly prevalent in grassland ecosystems that were traditionally managed as common pool resources (Fratkin, 1997). Policymakers in East Africa, the former Soviet Union, and China have made efforts to stave off desertification and overgrazing by privatizing formerly common grasslands as contracted land or private ranches instead of common-pool resources (Conte & Tilt, 2014; Humphrey & Sneath, 1996; McCabe et al., 2010; Wang et al., 2014; Zukosky, 2008).

While intended to prevent ecological degradation, grassland privatization policies in Inner Asia have been shown to increase grassland degradation while also increasing economic inequality among users (Li & Huntsinger, 2011; Taylor, 2012; Williams, 2002). Privatization has disrupted customary land management systems centered on flexible, seasonal grassland use and community-based decision-making (Taylor, 2006; Williams, 1996).

The failure of privatization to effectively regulate common-pool resource use has led social scientists to re-examine the tragedy of the commons and to distinguish common pool resources from open access resources. Open access resources

✉ Thomas Conte
thomasconte@gmail.com

[1] Rutgers University, The State University of New Jersey, New Brunswick, USA

Published online: 11 November 2021

are non-excludable resources that are difficult to govern effectively and police (Feeny et al., 1990; Ostrom, 1990). While open-access resources are susceptible to the tragedy of the commons, common-pool resources can be managed to curb individuals' tendency to overuse resources. Namely, overextraction is prevented through a cultural ethos that defines a clear delineation of users' access to resources and punishment of individuals who fail to observe norms surrounding resource use (Ostrom, 1990).

Although common pool resources can be effectively managed through social norms and regulations, how common pool resource use is affected by natural hazards is less clear. On the Inner Asian grasslands, environmental shocks such as drought, severe winter storms, and livestock disease often lead to livestock population collapses and contribute to rural poverty (Vernooy, 2011; SDC, 2010; UNDP, 2010; Templer et al., 1993). It is also unclear how environmental shocks affect resource users' decisions on how much of a resource to extract, including whether resource users are more or less cooperative with others during environmental shocks or resource scarcity (Bartos, 2015; Akitpis et al., 2011). Previous research indicates that societies that experience resource scarcity often have extensive sharing norms that extend beyond individual households (Ember et al., 2018). However, other studies have shown that resource scarcity may also lead cooperation and sharing networks to become limited to closely related kin (Gurven, 2004). Mongolia is an ideal place to study the effects of environmental shocks on common-pool resource use because it contains some of the world's most extensive common grasslands and experiences frequent severe winter storms and droughts (Thrift & Byambabaatar, 2015; Fernandez-Gimenez et al., 2015; UNDP, 2010; Swift & Siura, 2002; Templer et al., 1993).

## The Mongolian Grazing Commons and *Dzud* Disasters

Nomadic pastoralists have managed the Mongolian Plateau's grasslands as common-pool resources for at least three millennia (Lattimore, 1941). Grasslands were traditionally maintained as territories controlled by patrilineal clans, feudal princes, or Buddhist monasteries (Endicott, 2012). Following the establishment of the socialist Mongolian People's Republic in the 1920s, Mongolia transitioned to a command economy. Grassland access was regulated by collectives that set stocking rates and seasonal access to grasslands (Batsaikhan, 2014; Fernandez-Gimenez, 1999; Humphrey & Sneath, 1999).

After the collapse of socialism in the 1990s, Mongolia's pastoral economy was opened to international markets (Sneath, 2002). The end of socialism resulted in the growth of the number of families engaged in herding (Humphrey & Sneath, 1999). This has led to a dramatic increase in livestock numbers and has challenged how common pool resources were traditionally managed (Upton, 2008). Most pasture land in Mongolia has remained a common pool resource, but overgrazing has increased in the last twenty years (Hilker et al., 2014). This is partly due to increases in the population of cashmere goats, which provide the chief source of income for pastoralists, and an overall decline in nomadic mobility as herders seek to be closer to cities (Fernandez-Gimenez, 2001; Liu et al., 2013; Mearns, 1996).

Mongolian pastoralists manage common grassland resources through cooperation among groups of extended kin known as *khot ail*. *Khot ail* usually consists of two to ten interrelated families who co-manage livestock and occupy seasonal pastures based on customary use rights (Bold, 1996; Cooper, 1993; Fernandez-Gimenez, 1999; Mearns, 1993; Sneath, 2003). These families work together to conduct seasonal migrations, manage livestock, and prepare for the severe winter conditions expected on the Mongolian steppes. Preparation for hazardous winter conditions often involves cutting supplementary hay to feed livestock during times of scarcity, building livestock enclosures to shield animals from the weather, and taking animals on short distance migrations to areas where grass is abundant so they can gain fat reserves (Ericksen, 2014). Herders assert that there is little a family can do to save livestock during winter scarcity without adequate preparation of supplementary fodder. In addition, herding families tend to rely on their own supplies of supplementary fodder during the winter, and sharing emergency fodder with others is not customary.

In the 20$^{th}$ and 21$^{st}$ Centuries, the Mongolian Plateau has experienced a rise in unpredictable weather conditions, severe droughts, and winter weather events (SDC, 2010; UNDP, 2010). Key among these severe weather events is a natural hazard known as *dzud*. *Dzud* occur when snowstorms are followed by severely cold temperatures that cause an impenetrable layer of ice to form over the grassland, prevents livestock from grazing (Begzsuren et al., 2004). These conditions are particularly hazardous for pastoralists because they often lead to livestock mortality from starvation and exposure.

As annual precipitation and weather become more unpredictable on the Mongolian steppes, *dzud* are becoming increasingly common. National censuses of livestock numbers indicate that the Mongolian national livestock herd fluctuated between 40 and 55 million total animals between 2012 and 2015 (Eldevochir, 2016). Current estimates indicate that the Mongolian economy lost over 21 million livestock because of *dzud* between 1990 and 2010 (UNDP, 2010). The most recent nationwide *dzud* in the winter of 2009 – 2010 resulted in the death of over 8.5 million livestock, roughly 20% of the national livestock population (Vernooy, 2011). *Dzud* are a significant driver of rural poverty in Mongolia and

have forced many pastoral nomads to abandon herding after losing their livestock (Templer et al., 1993).

The Mongolian ethnographic record suggests nomadic herders rely on extended kin networks to mitigate *dzud* risks and co-manage common pool resources (Cooper, 1993; Murphy, 2014; Sneath, 1993). These cooperative networks help herders coordinate seasonal migrations, herd livestock, and prepare for risks (Bold, 1996). Before the 20$^{th}$ Century, these informal networks were supplemented by support from feudal princes, clan leaders, and Buddhist monasteries. During the socialist period, collectives provided mechanized transport for seasonal migration, regulated land use, and provided supplementary winter fodder for livestock (Humphrey & Sneath, 1996). This state social support has disappeared in the present, and herders themselves are now largely responsible for *dzud* mitigation.

In the absence of the state social support provided to herders under socialism, informal support networks are becoming increasingly crucial for herding tasks and risk management (Ericksen, 2014; Murphy, 2014). However, how a *dzud* affects herders' ability to co-manage common pool resources is not well understood. This is because the synchronous nature of *dzud* may make herders less able to effectively co-manage common grasslands. After all, all herders are simultaneously dependent on diminished resources.

This study utilizes common pool resource experimental economic games to test the following predictions: 1) individuals will behave more selfishly in common-pool resource games when presented with a game that is framed as a *dzud* than in a game not framed as a disaster, and 2) individuals will expect other players to behave more selfishly in common-pool resource games framed as a *dzud* than in games not framed as disasters. I used three different common pool resource games to test for the effects of a disaster frame: a game where two anonymous players have access to a common pot of money that is certain, one where the amount of money in the common pot can change by chance, and one where the amount of money in the common pot can change, and the probability of change is framed as a *dzud*. These games were performed in 2015 and 2016 in two regions of Mongolia, Orkhon, Bulgan Province, which has low-to-moderate *dzud* risk, and Tosontsengel, Zavkhan Province, which is highly susceptible to *dzud*.

## Materials and Methods: Common Pool Resource Economic Games

Social scientists use experimental economic games to assess economic decision-making in controlled settings (Cronk & Leech, 2013). Experimental games allow researchers to control social, economic, and environmental factors in real-world economic decision-making and isolate individual and group behavioral responses to economic or cultural stimuli (Cronk, 2007). Because the various experimental games rely on similar sets of assumptions, games have been successfully used in both laboratory and field settings.

Experimental games also enable researchers to develop scenarios designed to test cultural or behavioral hypotheses and compare test versions of experimental games to control versions. Numerous studies have measured priming or framing effects, which can take the form of implicit cues of observation or culturally salient terms or framing of the game decision (Hagen & Hammerstein, 2006; Haley & Fessler, 2005). Framing effects have been observed in a variety of experimental studies both with Western and non-Western populations and highlight the intersection of social norms, membership in organizations, and economic behavior (Gelcich et al., 2013; Gerkey, 2013; Dreber et al., 2013; Cronk & Wasielewski, 2008; Camerer & Fehr, 2004).

Common pool resource games allow players to draw funds from a common pot of money with equal access to all players. The experimenters place an incentive on taking as little as possible from the common pot by ensuring players not only may they keep whatever they withdrew from the common pot, but also that anything remaining in the pot after all players have withdrawn funds will be multiplied by a factor greater than one and divided evenly among the players (Ostrom et al., 1994). However, if the cumulative withdrawals of all players are greater than the total sum of money in the common pot, then none of the players gets to keep any of the funds they withdrew. The Pareto optimal decision occurs when both players decide to take nothing from the common pot. Each player yields the maximum return in this case because the entire common pot is multiplied and then divided between the players evenly. Thus, players must negotiate between the Pareto optimal decision and the Nash Equilibrium decision in which the players' cumulative extraction is greater than the total amount of money in the common pot (Cardenas et al., 2015). Therefore, the game simulates the subtractability inherent in common-pool resources and incentivizes cooperation (Gardner et al., 1990; Walker et al., 1990).

Common pool resource games have been used to study the effects of uncertainty in the total size of the common pot and allowing communication among players (Messick et al., 1988; Rapoport et al., 1993). They have also been used to study the effects of participation in religious rituals on players' willingness to behave cooperatively in common-pool resource scenarios (Ruffle & Sosis, 2007; Sosis & Ruffle, 2003). Finally, common pool resource games have been used to explore the effects of membership in social institutions on

players' tendency to over-exploit resources (Gelcich et al., 2013).

## Field Site Descriptions

### Tosontsengel Sum, Zavkhan Province, Mongolia

Tosontsengel is a subdivision (*sum*) of Zavkhan Province in western Mongolia. The region is known for being one of the most climatologically harsh in Mongolia. It holds the record for the coldest temperature recorded in Mongolia (-52.9ºC) and the highest barometric pressure ever recorded globally (Purevjaw et al., 2015). The region consists of mountainous forest-steppe and is within the central Mongolian Khangai mountain range. The population of Tosontsengel is just under 9,000, making it the largest *sum* by population in Zavkhan Province after the provincial capital. Most of the population are Khalkha Mongols (Mongolia's largest ethnic group). Most rural families' chief source of income is animal husbandry, and pastoralists typically specialize in herds of sheep, goats, and cattle. Wool and cashmere are the primary sources of income, and these are sold to traders in Tosontsengel's administrative village who transport them to Ulaanbaatar, the national capital. Some families also make supplementary income from cutting timber, driving trucks, producing handicrafts, and operating small shops.

Tosontsengel pastoralists are nomadic and undertake four to six seasonal movements for 40–80 km of annual migration. They spend the winter in sheltered mountain valleys and move along rivers during the spring. During the summer, families move onto river floodplains where land and water resources are abundant before moving back into river valleys in the autumn. During the winter months, families tend to camp with extended kin in *khot ail* groupings and are heavily dependent on supplementary sources of livestock fodder, which they purchase or cut in designated hay fields. The region is at higher risk for winter *dzud* than other provinces of Mongolia, and herders are keenly aware of winter risks and potential livestock mortality (Swift & Siura, 2002).

### Orkhon Sum, Bulgan Province, Mongolia

Orkhon is a *sum* of Bulgan Province in central Mongolia. Relative to Tosontsengel, the region is noted for being less climatologically harsh and experiences milder winters. The *sum* is mainly mountainous forest-steppe and is also within the central Mongolian Khangai range. The population of the *sum* is just over 3,000, the majority of which are nomadic pastoralists. The *sum* is adjacent to the provincial capital of Bulgan Province and Erdenet, Mongolia's second-largest city. Most of the population is Khalkha Mongols, but a substantial number of herders from western Mongolia (particularly Zavkhan and Uvs Provinces) have moved to the *sum* in the last three decades to take advantage of Orkhon's proximity to two major cities.

Orkhon's proximity to urban markets places it in a unique economic position relative to other areas of the Mongolian countryside. Rural families in Orkhon are chiefly employed in animal husbandry. However, unlike many other herding communities that hire intermediaries to transport livestock products to Ulaanbaatar, Orkhon pastoralists can directly sell livestock products in the provincial capital and Erdenet. Pastoral families specialize in herds of sheep, horses, goats, and cattle. The region is also noted as being one of the leading centers for the production of *airag*, a mildly alcoholic beverage made from fermented mare's milk.

Orkhon's pastoral families are seasonally nomadic and undertake four to six seasonal movements for a total annual migration of 40–100 km. Families typically spend the winter in sheltered valleys on the slopes of low mountains. During the spring months, they move to lower elevations before moving to the banks of the Orkhon River or the shores of numerous small lakes during the summer months. Relative to other regions of Mongolia, Bulgan Province experiences lower winter livestock mortality and less risk of winter *dzud* (Tachirii et al., 2008; Templer et al., 1993). As a result, Orkhon herders typically report being more concerned about the effects of overgrazing, livestock population density, and inward migration of herders from other provinces than winter *dzud*.

## Procedure

Because this study is one of the first applications of experimental economic games in rural Mongolia (although, see Gil-White, 2004 for another application), common pool resource games were piloted with a sample of 60 participants in Orkhon in June 2015. A more extensive study with a sample of 120 participants was then conducted in Tosontsengel in December 2016. Tables 1 and 2 illustrate the sample population statistics for both study locations.

### Game Versions: Standard, Stochastic, and Dzud Framed

Three versions of common-pool resource games were used in both study locations: a standard common pool resource game in which the amount of money in the common pot is certain, a stochastic version where there is a probability that the amount of money in the common pot will be

**Table 1** Orkhon Sample Population Statistics

| Version | Sex | Age (*M, SD*) | Animals (*M, SD*)[1] | Children (*M, SD*) | Years of Herding Experience (*M, SD*) |
|---|---|---|---|---|---|
| **Standard** | 7 M, 13F | 37.4 (10.3) | 495.3 (360.2) | 2.2 (1.1) | 14.0 (8.8) |
| **Stochastic** | 10 M, 10F | 43.8 (9.5) | 366.3 (275.6) | 2.7 (1.1) | 21.7 (8.9) |
| ***Dzud*** | 7 M, 13F | 43.6 (9.6) | 502.9 (424.1) | 2.6 (1.0) | 20.3 (8.3) |
| **Total** | 24 M, 36F | 41.6 (10.1) | 457.9 (360.1) | 2.5 (1.1) | 18.6 (9.2) |

[1]Animals category includes a participant's entire herd size of various livestock species

reduced and a *dzud* framed version which is the same as the stochastic version, save that the probability that the amount of money in the common pot will be reduced is framed as a hypothetical *dzud*. Each version was played with pairs of players, and each participant played only one version.

Each game presented players with a hypothetical envelope containing 20,000 Mongolian *tugriks* (MNT), which at the time of data collection was equivalent to approximately $8 (enough to buy 10 kg of flour or roughly the equivalent of one day's wages based on Mongolia's 2016 GDP per capita of $3,660). In the standard version, players were instructed that the 20,000 MNT in the hypothetical envelope was fixed and that they and the player they had been paired with could remove any amount of money they wished from the envelope in 1,000 MNT increments. They were then told that they would not know the amount of money the person they were paired with would take from the envelope and that if there was any money left in the envelope after both players made their decision, that remainder would be multiplied by a factor greater than 1 and divided equally between both players. If the summed withdrawals of both players exceeded 20,000 MNT, then neither player would receive any payment.

In the Orkhon common pool resource games, I used a multiplier of 2. However, after consideration, this multiplier was changed to 1.5 in the Tosontsengel games. When a multiplier of 2 is used, a player who decides to remove all 20,000 MNT from the envelope, and who is paired with a player who takes 0 MNT from the envelope, cannot do any better than if he or she decided to leave all the money in the common envelope. This creates a coordination problem that requires both players to understand the mathematics of how the game works rather than a conflict of interest that depends on trusting the other player to cooperate. A multiplier of 1.5, however, creates this conflict of interest because it is smaller than the number of people playing the game. Thus, players can attain the Pareto optimal payout only through cooperation when the multiplier is 1.5.

The rules for the stochastic version are the same as those of the standard version, but the amount of money in the envelope is uncertain. Along with the rules described above, players in the stochastic version were informed that the amount of money in the envelope could change based on the roll of a 10-sided die (rolled by the researchers) after they and the individual they were paired with made their decisions on how much money to withdraw. If the die roll was a 1, 2, or 3, then the amount of money in the envelope would be reduced by 20% to 16,000 MNT. If the die roll was a 3, 4, 5, 6, 7, 8, 9, or 10, then the money in the envelope would remain 20,000 MNT. The rules of the *dzud*-framed and stochastic versions are identical, but the *dzud*-framed version is framed as a "*dzud* game" in which the amount of money in the envelope is uncertain because of the possibility of a *dzud*. The probabilities and reductions in the stochastic and *dzud*-framed versions were selected because *dzud* occurred in 30% of winters between 1990 and 2010. The most severe of these killed 20% of the national livestock herd (UNDP, 2010). Instructions

**Table 2** Tosontsengel Sample Population Statistics

| Version | Sex | Age *(M, SD)* | Animals *(M, SD)*[1] | Children *(M, SD)* | Years of Herding Experience *(M, SD)* |
|---|---|---|---|---|---|
| Standard | 13 M, 14F | 44.0 (14.7) | 78.8 (73.8) | 3.07 (2.0) | 13.80 (14.2) |
| Stochastic | 15 M, 14F | 39.7 (12.7) | 59.2 (64.2) | 2.75 (1.5) | 10.85 (10.4) |
| *Dzud* | 13 M, 18F[1] | 40.1 (10.8) | 73.6 (81.5) | 2.81 (1.9) | 14.43 (14.4) |
| Total | 41 M, 46F[2] | 41.4 (12.8) | 70.5 (73.3) | 2.87 (1.8) | 13.02 (13.1) |

[1]Animals category includes a participant's entire herd size of various livestock species

[2]1 participant did not mark his or her sex on participation form

[3]A total of 32 participants were omitted from the analysis for failing the study comprehension check

for both games were translated and back-translated into standard Khalkha Mongolian.

## Orkhon Game Procedure

In June 2015, games were conducted at the annual Youth Day Festival in a *bag* (an administrative subdivision of a *sum* equivalent to a township) of Orkhon. Games were conducted at the *bag*'s cultural center, a central meeting place where festivities, meetings, and elections are held. A convenience sample of 60 male and female participants was recruited from festival attendees and was screened based on two criteria: if they were 18 years or older and if they were rural residents of Orkhon *sum*.

Participants were gathered at the front courtyard of the cultural center and instructed that they should remain in the courtyard until they had completed the activity. Once 60 participants had been gathered, cards numbered from 1—60 were randomly distributed to participants, and they were instructed to enter the cultural center once their number had been called. Twenty numbers were randomly selected, and field assistants also continued to supervise the remaining participants to minimize potential observer effects.

A field assistant fluent in Mongolian translated instructions and participants were assured their participation in the activity was voluntary. Participants were also informed they would be playing with real money, which would be paid in cash after the activity. They were also made aware that although the game would be anonymous, they would be playing with a random individual also sitting in the room.

Following explaining the rules, the field assistant presented participants with instructions according to the version they were playing. Then participants were given four randomly chosen examples of game situations. To avoid confusion, the field assistant also informed participants playing the stochastic or *dzud* framed versions that the experimenters would be rolling the 10-sided die after players had made their decisions. After these examples were completed and participants were given the opportunity to ask clarifying questions, the field assistant instructed players to make two decisions: how much money they would like to withdraw from the common envelope and how much money they expected the player they were paired with would withdraw from the envelope. After they had marked their decisions on data recording sheets, players' decision sheets were randomly paired with other players. While payouts were being calculated, participants were given an understanding check in which they were asked to calculate example games.

After completing the game, participants were led out of the cultural center and were not permitted to re-enter the area where other participants were waiting. The above process was repeated for the remaining 40 participants until each of the three game versions had been completed with 20 participants each. After the game, participants were paid the money they had earned in sealed manila envelopes marked only with their participation number. Twelve participants were then randomly selected (four from each version) for follow-up interviews.

## Tosontsengel Game Procedure

In December 2016, common pool resource games were conducted at the Tosontsengel Elementary School. A convenience sample of 120 male and female participants was recruited from the local pastoral population based on two criteria: they were 18 years or older, and they were pastoral residents of Tosontsengel. Due to cold temperatures, participants were gathered in the elementary school's main classroom building, where they remained until they were called to play the game. Each participant was randomly given a card labeled from 1—120 and instructed that they would be randomly called in groups of 40. Once called, participants were led to the school library by a field assistant and were seated at tables where they were provided game instructions corresponding to the version they would be playing. Like in the Orkhon games, a field assistant explained the game rules, provided examples, and answered clarifying questions.

After players' decision sheets were collected and randomly paired, players were given a paper survey that contained an understanding check, a set of Likert-scale survey questions (described in Table 3) regarding the game, a set of survey variables that assessed how zero-sum oriented individual players felt, and a set of zero-sum orientation questions related to the game (Sznycer, 2016). Because understanding check questions that required participants to compute answers to game situations caused a great deal of stress among participants in Orkhon, the paper survey also included a battery of five True/False questions regarding game rules in Tosontsengel. Participants were retained in the sample if they answered at least 3/5 of these questions correctly. In total, 32 players were excluded from the analysis in the Tosontsengel sample for failing the understanding check.

Payments were given to study participants in sealed white envelopes marked only with a player's participation number. Following the distribution of payments, participants were led out of the study location by a field assistant and allowed to

**Table 3** Mean Taking and Expected Taking in Orkhon

| Version | N | Amount Taken (*M*, *SD*) | Expected Taking (*M*, *SD*) |
|---|---|---|---|
| **Standard** | 20 | 5,100 (2,552.6) | 6,400 (3,409) |
| **Stochastic** | 20 | 5,000 (2,635.8) | 4,900 (2,023.5) |
| ***Dzud*** | 20 | 6,100 (3,210.2) | 7,350 (2,412.2) |
| **Total** | 60 | 5,400 (2,811.6) | 6,216 (2,823) |

leave. They were not permitted to re-enter the main school building where other participants were waiting. The procedure above was then completed with the remaining 80 study participants in sets of 40.

### Results Analysis

I used Pearson correlations and linear regressions to analyze the relationship between demographic variables and survey questions, and the amount of money players took from the envelope and expected the person they were paired with to take. Because Shapiro-Wilks Tests indicate the distributions of the amount players took from the envelope and expected others to take are not normally distributed, I used Kruskal-Wallace Tests to test for differences in taking and expected taking across the three game versions. I used Mann–Whitney U tests to assess the differences between male and female study participants across the three game versions in each study site. The data were analyzed using IBM SPSS Version 20.

## Results

### Orkhon Game Results

In the Orkhon games, participants in the standard version removed 5,100 MNT (25.5%, SD = 2,552.6) from the envelope on average and 5,000 MNT (25%, SD = 2635.8) and 6100 MNT (30.5%, SD = 3,210.2) in the stochastic and *dzud*-framed versions, respectively. Players in the Orkhon sample expected the players they were paired with to remove 6,400 MNT (32%, SD = 3,409) from the envelope in the standard version and 4,900 MNT (24.5%, SD = 2,023.5) and 7,350 (36.8%, SD = 2,412.2) in the stochastic and *dzud*-framed versions, respectively. Kruskal-Wallace tests to compare rates of taking and expected taking across game versions revealed that the amount players removed from the hypothetical common pot does not statistically significantly differ across versions ($p = 0.64$). However, the amount of money players expected the individuals they were paired with to take does statistically significantly differ ($p = 0.01$) across versions. Players in the *dzud*-framed version expected the players they were paired with to take significantly more money than in the stochastic version, but not in the standard version. Tables 3 and 4 illustrate these results.

There were no significant correlations between the demographic variables collected for each of the 60 game participants and the amount of money they removed from the envelope or expected other players to take. However, the amount of money players took from the envelope is weakly significantly positively correlated ($R = 0.35$, $p \leq 0.01$) with how much money they expected the player they were paired with to take. Finally, Mann–Whitney U Tests revealed no statistically significant differences in the amount of money male and female participants removed from the envelope or expected other players to remove from the envelope across the three versions.

**Table 4** Kruskal-Wallace Comparison of Taking and Expected Taking across Versions in Orkhon

| Category | N | Test Statistic | D*f* | *p*-value |
|---|---|---|---|---|
| **Amount Taken** | 60 | 0.88 | 2 | 0.64 |
| **Expected Taking** | 60 | 9.26 | 2 | 0.01** |

**Significant comparison at $p \leq 0.01$

**Table 5** Mean Taking and Expected Taking in Tosontsengel

| Version | Amount Taken (*M, SD*) | Expected Taking (*M, SD*) |
|---|---|---|
| **Standard** | 4,370. (4,133.8) | 4,222.2 (4,423.1) |
| **Stochastic** | 5,275.9 (3,954.2) | 4,246.4 (2,502.2) |
| ***Dzud*** | 4,406.2 (3,025.3) | 4,343.7 (3,469.8) |
| **Total** | 4,681.8 (3,684.5) | 4,272.7 (3,486.3) |

### Tosontsengel Game Results

In the Tosontsengel games, players in the standard version removed an average of 4,370.4 MNT (21.9%, SD = 4,133.5) from the common envelope and 5,275.9 MNT (26.4%, SD = 3,954.2) and 4,406.2 MNT (22%, SD = 3,025.3) in the stochastic and *dzud*-framed versions, respectively. Players in the Tosontsengel games expected other players to remove 4,222.2 MNT (21.1%, SD = 4,423.1) in the standard version, 4,246.4 MNT (21.2%, SD = 2,502.2) in the stochastic version, and 4,343.7 MNT (21.7%, SD = 3,469.8) in the *dzud*-framed versions. Table 5 illustrates these results. Kruskal-Wallace tests (illustrated in Table 6) to compare taking and expected taking in the Tosontsengel sample reveal no significant differences among the versions for the amount players took from the hypothetical common pot ($p = 0.48$) or the amount they expected other players to take ($p = 0.48$). It should also be noted that the statistically insignificant differences described above do not change when the 32 players who were omitted from the analyses for failing the understanding check are included in the analysis.

**Table 6** Kruskal-Wallace Comparison of Taking and Expected Taking across Versions in Tosontsengel

| | N | Test Statistic | D*f* | *p*-value |
|---|---|---|---|---|
| **Amount Taken** | 88 | 1.47 | 2 | 0.48 |
| **Expected Taking** | 88 | 1.46 | 2 | 0.48 |

To compare male and female players' decision-making, Mann–Whitney U Tests were performed on both taking and expected taking rates across the three versions. These analyses indicate no significant differences in either taking ($p = 0.29$) or expected taking ($p = 0.88$) between male and female study participants.

Correlational analyses revealed no significant correlations between the demographic variables collected for each of the 88 study participants and the amount players removed from the envelope or expected the player they were paired with to take. However, the amount players removed from the hypothetical common pot across versions is significantly strongly positively correlated with the amount players expected others to take ($R = 0.69$, $p \leq 0.01$).

To assess whether the post-game survey questions, zero-sum orientation questions and game-specific zero-sum orientation questions described in Table 7) could be combined into indices that measure unified constructs, I performed reliability analyses on these variables. Reliability analyses revealed that none of the variables designed to measure players' attitudes toward the game, zero-sum orientation, or game-specific zero-sum orientation could be reliably formed into indices. Therefore, Kruskal-Wallace tests were performed on each survey variable for these three categories across game versions. These tests revealed no significant differences among the three game versions and participants' responses to post-game survey questions and the game-specific zero-sum orientation questions. However, one significant comparison for the fourth zero-sum variable was "Cooperating with others is more profitable than taking advantage of others" ($N = 87$, Test Stat. $= 7.226$, $p = 0.03$). In the case of this variable, players in the *dzud*-framed game were more likely to disagree with the variable statement than players in the standard game, but not the stochastic game. Table 8 shows participants' mean responses to the survey questions described above.

Finally, I performed Pearson correlations to assess the relationships between each post-game survey variable and rates of taking or expected taking across the three game versions. The results of these analyses indicate that there are no significant correlations between the zero-sum orientation variables and game-specific zero-sum orientation variables and the amount players.

took from the envelope or expected other players to take. In the game-specific survey variables, the statement "I was worried that I would take too much money from the envelope" is weakly positively correlated with the amount of money a player took ($R = 0.22$, $p = 0.04$).

The correlational analyses between survey variables and expected taking revealed no significant correlations between zero-sum orientation variables and expected taking. However, for the game-specific survey questions, players' responses to the survey variables "I wanted to earn more money than the person I was paired with" and "I believed the person I was paired with wanted to earn more money than me" are both weakly positively correlated with the amount of money players across versions expected others to take ($R = 0.26$, $p = 0.01$, $R = 0.27$, $p = 0.01$, respectively). Furthermore, for the game-specific zero-sum orientation variables, the survey variable "No one can be successful in the game unless they bring

**Table 7** Tosontsengel Post-Game Survey Variables[1]

| **Game Survey Statements:** |
|---|
| 1. I was worried that I would take too much money from the envelope |
| 2. I was worried that the person I was paired with would take too much money from the envelope |
| 3. I wanted to cooperate with the person I was paired with |
| 4. I wanted to earn more money than the person I was paired with |
| 5. I believed that the person I was paired with wanted to earn more money than me |
| **Zero-Sum Orientation Statements:** |
| 1. It is only by stepping on others that people get ahead |
| 2. No one can achieve much unless they bring others down |
| 3. Wealth can definitely be created without exploiting others |
| 4. Cooperating with others is more profitable than taking advantage of others |
| 5. If someone makes a profit, it will be at the expense of someone else |
| **Game Zero-Sum Orientation Statements:** |
| 1. The only way to make money in the game is to step on others |
| 2. No one can be successful in the game unless they bring others down |
| 3. Both players can definitely make money in the game without exploiting each other |
| 4. Cooperating with the person you were paired with is more profitable than taking advantage of the person |
| 5. If someone makes a profit in the game, it will be at the expense of the other person |

[1]Variables coded on a 5-point scale where 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree

**Table 8** Mean responses to Tosontsengel post-game survey variables[1]

| Survey Variable | Standard *(M, SD)* | Stochastic *(M, SD)* | *Dzud (M, SD)* | Total *(M, SD)* |
|---|---|---|---|---|
| **Game Survey Statements** | | | | |
| Game 1 | 3.4 (0.8) | 3.4 (0.9) | 3.2 (1.0) | 3.4 (0.9) |
| Game 2 | 2.8 (1.1) | 2.8 (1.2) | 2.8 (1.1) | 2.8 (1.1) |
| Game 3 | 3.6 (1.0) | 3.6 (1.2) | 3.8 (0.9) | 3.7 (1.0) |
| Game 4 | 2.0 (1.0) | 2.2 (1.0) | 2.4 (1.1) | 2.2 (1.1) |
| Game 5 | 3.0 (1.2) | 2.7 (0.9) | 2.9 (1.1) | 2.9 (1.1) |
| **Zero-Sum Orientation statements** | | | | |
| Zero-Sum 1 | 1.8 (1.2) | 1.7 (1.2) | 2.2 (1.4) | 1.9 (1.3) |
| Zero-Sum 2 | 3.2 (1.4) | 3.4 (1.3) | 3.7 (1.2) | 3.5 (1.3) |
| Zero-Sum 3 | 3.8 (1.1) | 3.7 (1.2) | 3.8 (1.2) | 3.8 (1.2) |
| Zero-Sum 4 | 4.4 (0.8) | 3.9 (1.2) | 3.6 (1.3) | 3.9 (1.2) |
| Zero-Sum 5 | 3.2 (1.4) | 4.4 (1.0) | 3.3 (1.2) | 3.3 (1.2) |
| **Game Zero-Sum Statements** | | | | |
| Game Zero-Sum 1 | 2.3 (1.2) | 2.1 (1.1) | 2.3 (1.0) | 2.3 (1.1) |
| Game Zero-Sum 2 | 2.5 (1.0) | 2.7 (1.1) | 2.4 (0.9) | 2.5 (1.0) |
| Game Zero-Sum 3 | 4.0 (1.0) | 3.8 (1.0) | 3.7 (0.9) | 3.8 (1.0) |
| Game Zero-Sum 4 | 3.5 (1.3) | 3.1 (1.0) | 3.3 (1.2) | 3.3 (1.2) |
| Game Zero-Sum 5 | 2.6 (1.3) | 2.5 (1.2) | 2.9 (0.9) | 2.7 (1.1) |

[1]All survey variables coded on a 5-point scale in which 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree

others down" is weakly positively correlated with the amount players expected others to take ($R = 0.26$, $p = 0.02$).

## Discussion

This study provides several insights on how Mongolian nomadic pastoralists treat common pool resource decision-making. However, the results are inconclusive in predicting how *dzud* might affect herders' willingness to co-manage common pool resources cooperatively. The Mongolian Plateau boasts a long tradition of successful common pool resource management and a system of traditional land laws that prevent unrestricted access to land and flexible, seasonal grassland management (Endicott, 2012). This study began with two predictions that players in the common pool resource games would take more money for themselves and expect other players to take more when presented with a game framed as a *dzud*. While neither of these predictions is supported in the Tosontsengel sample and have limited support in the Orkhon sample, this study represents the first attempt to experimentally assess the effects of *dzud* on common pool resource decision making in rural Mongolia.

The results in both study sites indicate that herders may be acutely aware of the possibility of over-extracting common pool resources. Thus, they may have played the game conservatively to prevent the potential of overdrawing from the hypothetical common pot. In total, 0 of the 30 games in the Orkhon sample resulted in over-extraction from the common envelope, and only 2 of 44 games in the Tosontsengel sample resulted in over-extraction. This may indicate the strength of cultural norms and rules associated with common pool resource use in Mongolia. For example, one player in the Orkhon sample commented that she did not worry at all about overdrawing from the common envelope because "I was playing with other Mongols, and I'm sure they would play the game the same way I would." This interpretation is further evidenced by the strong positive correlation ($R = 0.69$, $p \leq 0.01$) between the amount of money players took from the common envelope and how much they expected other players to take across the three game versions in the Tosontsengel sample. Thus, these results suggest that there may be a solid collective ethos among Mongolian pastoralists regarding common pool resource management.

In Tosontsengel, while summer pasture tends to be open access with little regulation, herders are acutely aware of the boundaries between winter pastures and seek to prevent out-of-season access to winter land because of the tendency for Zavkhan Province to experience harsh winter conditions. In interviews, Tosontsengel herders asserted that they believe *dzud* often drive people to behave more selfishly simply because they may be physically unable to help other families or are unwilling to ask others for help. When asked if he could ask for help from others during a *dzud*, one Tosontsengel herder commented that "Asking other people for help during a *dzud* is like asking your brother to let his animals

starve so yours can eat." As a result of the necessity for grazing resources and supplementary fodder during *dzud*, many Tosontsengel herders commented that they felt the best course of action during a *dzud* is to get away from other families to not densely concentrate the number of sick or starving livestock on already limited pastures.

The lack of a framing effect in the Tosontsengel sample might be due to players' confidence in their ability to predict other individuals' behavior and the fact that many individuals in Tosontsengel acknowledge difficult winter conditions as something they regularly experience in their location. One herder commented that every winter in Tosontsengel presents unfavorable conditions and that herders from any other region of Mongolia would call even a normal winter in Tosontsengel a *dzud* winter.

Similar to the Tosontsengel sample, there were no significant differences in individual decision-making across the standard, stochastic, and disaster-framed games in Orkhon. However, the statistically significant difference between the stochastic and disaster framed versions in the amount of money players expected others to take lends some support to the second prediction that players would expect others to take more from the common envelope if the game was framed as a *dzud*. While players in the *dzud*-framed version in Orkhon did not take significantly more from the common envelope than in the other two versions, they expected the players they were paired with to remove more from the envelope than in the other versions.

To explore the significant differences in expected taking across game versions in Orkhon, I asked several participants to interpret the game results. These players asserted that they did not feel worried that they or their partners' combined decisions would result in taking too much money from the envelope. However, players in the disaster-framed version of the game asserted that they felt the players they had been paired with would take more money from the envelope than they did. While this could be interpreted as a perception of greater selfishness on the part of other players, the interviewees did not attribute this view to selfishness. For example, several players in the *dzud*-framed game asserted that while they did not choose to remove a more significant amount of money from the envelope because of the possibility of a disaster, their partners might choose to do so because they might need this money if a *dzud* were to happen. Therefore individuals often cited a concern for other players' needs, rather than selfishness, as the reason they might take more out of the envelope. This may be characteristic of the fact that rural Mongolians are generally cash-poor and need cash during *dzud* to buy supplementary fodder (Murphy, 2018).

The difference in expectations of player behavior in the *dzud*-framed version of the game in the Orkhon and Tosontsengel samples may also be related to the fact that Orkhon is experiencing net inward migration of herders from surrounding provinces while Tosontsengel is not. Because of its central location near two major cities, Orkhon is a prime location for herding families to be close to two urban markets for livestock products. This economic situation is quite uncharacteristic for much of the Mongolian countryside, where herders rely on intermediaries to sell livestock products in rural markets before they are shipped to Ulaanbaatar. Therefore, Orkhon has seen a significant degree of inward migration of herding families over the last two decades, especially from Mongolia's more remote western provinces. Herders in Orkhon often cite this inward migration as one of their chief concerns. Many attribute it to an increase in livestock density and overgrazing in a region where herd sizes are already larger than average. Therefore, the weaker positive correlation ($R = 0.35$, $p \leq 0.01$) between taking and expected taking in Orkhon relative to the strong positive correlation ($R = 0.69$, $p \leq 0.01$) between the two in Tosontsengel may indicate that players felt less confident in their ability to predict others' behavior in Orkhon than in Tosontsengel.

## Conclusion

This study represents the first-ever application of common-pool resource games in rural Mongolia, where common property systems are still functioning and codified in local tradition and national policy. The results indicate that Mongolian pastoralists can effectively manage common-pool resource decisions in an experimental setting when paired with a single individual in a non-iterated experimental game. The results support the effectiveness of cultural values and social norms for enabling individuals to avoid over-extracting common-pool resources and the ability to predict other resource users' behavior.

Regarding the original study predictions that the presence of a *dzud*-frame would lead rural Mongolians to behave more selfishly and expect others to do the same, there is only limited support for the expectation that other individuals would extract more from a common pool resource when faced with a potential *dzud*. These inconclusive results may be due to two possible reasons. First, players could have been so confident that neither they nor the people they were paired with would remove enough from the common envelope to risk destroying the resource. This confidence may have been strong enough that players who were faced with the stochastic and *dzud*-framed versions of the game did not alter their behavior significantly from those playing the game in which the amount of money in the common envelope was certain. Second, it is possible that the *dzud*-frame was not strong enough to elicit psychological or behavioral responses in the game. This may be because the *dzud*-frame presents a counterfactual that players might have disregarded or which did not influence how they made their decision.

In the future, studies aiming to explore the potential effects of natural disasters on Mongolian herders' economic and social decision-making should focus on the following. First, because herders often assert that they are unable to help others during *dzud* but can assist family and neighbors both before and after *dzud*, future studies might explore *dzud*'s effect on cooperative responses to winter preparation and recovery. In addition, future studies should employ an iterated common pool resource game with a built-in probability that a natural disaster will reduce available resources. In this way, the annual probability for a winter *dzud* could be more effectively simulated than in a non-iterated game. A within subjects game in which participants are allowed to play the game more than once, or an iterated game in which the amount of money in the common envelope changes during iterations could also more accurately model real-world common pool resource management than the game used in this study. Finally, while this study provides insights into the possibility that a collective ethos regarding common pool resource use may prevent over-extraction, future experimental game studies in Mongolia should include a greater qualitative and quantitative investigation into the role of collective values in governing resource use behavior.

**Acknowledgements** I would like to thank The Human Generosity Project and Drs. Lee Cronk, Athena Aktipis, and Daniel Sznycer for their advice on methods and data analysis. I would also like to thank Dr. Clifford Montagne, Badamgarav Dovchin, Erdenebadrakh Dovchin, and the BioRegions International 2015 summer field team for their assistance. Finally, I thank the pastoral communities of Tosontsengel and Orkhon, Mongolia, for their hospitality and assistance during data collection.

**Funding** This research was supported by funding from the National Science Foundation (Grant Number 1627439), The Fulbright Institute of International Education, and the American Center for Mongolian Studies.

**Data Availability** The data sets generated during the current study are available at the following link: [LINK].

## Declarations

**Informed Consent** This project and study procedures were reviewed by the Rutgers University Institutional Review Board for ethical compliance. Participation in this project was voluntary and based on verbal consent from study participants.

## References

Aktipis, C. A., Cronk, L., & de Aguiar, R. (2011). Risk-pooling and herd survival: An agent-based model of a Maasai gift-giving system. *Human Ecology, 39*, 131–140.

Bartos, V. (2015). Seasonal scarcity and sharing norms. *CERGE-EI in Prague,* May 2015.

Batsaikhan, E. O. (2014). *Mongolia: Becoming an Nation State (1911–1952).* Bitpress Printing Company.

Begzsuren, S., Ellis, J. E., Ojima, D. S., Coughenour, M. B., & Chuluun, T. (2004). Livestock responses to droughts and severe winter weather in the Gobi Three Beauty National Park. *Mongolia. Journal of Arid Environments, 59*(4), 785–796.

Berkes, F. (2006). From Community-Based Resource Management to Complex Systems: The Scale Issue and Marine Commons. *Ecology & Society* 11(1).

Bold, B. (1996). Socio-economic segmentation – Khot-ail in nomadic livestock keeping in Mongolia. *Nomadic Peoples, 39*, 69–86.

Camerer, C. F., Fehr, E. (2004). Measuring social norms and preferences using experimental games: A guide for social scientists. In *Foundations of human sociality: Economic experiments and ethnographic evidence from fifteen small-scale societies*: 55–95.

Cardenas, J., Mantilla, C., & Sethi, R. (2015). Stable Sampling Equilibrium in Common Pool Resource Games. *Games, 6*, 299–317.

Conte, T. J., & Tilt, B. (2014). The Effects of China's Grassland Contract Policy on Pastoralists' Attitudes towards Cooperation in an Inner Mongolian Banner. *Human Ecology, 42*, 837–846.

Cooper, L. (1993). Patterns of mutual assistance in the Mongolian pastoral economy. *Nomadic Peoples, 33*, 153–162.

Cronk, L., & Leech, B. (2013). *Meeting at Grand Central: Understanding the Social and Evolutionary Roots of Cooperation*. Princeton University Press.

Cronk, L. (2007). The influence of cultural framing on play in the trust game: A Maasai example. *Evolution and Human Behavior, 28*(5), 352–358.

Cronk, L., & Wasielewski, H. (2008). An unfamiliar social norm rapidly produces framing effects in an economic game. *Journal of Evolutionary Psychology, 6*(4), 283–308.

Dreber, A., Ellingsen, T., Johannesson, M., & Rand, D. G. (2013). Do people care about social context? Framing effects in dictator games? *Experimental Economics, 16*, 349–371.

Eldevochir, E. (2016). Livestock Statistics in Mongolia *Asia and Pacific Commission on Agricultural Statistics* 26th Session, Thimphu, Bhutan.

Ember, C. R., Skoggard, I., Ringen, E. J., & Farrer, M. (2018). Our better nature: Does resource stress predict beyond-household sharing? *Evolution and Human Behavior, 39*(4), 380–391.

Endicott, E. (2012). A History of Land Use in Mongolia: The Thirteenth Century to the Present. Palgrave Macmillan.

Ericksen, A. (2014). Depend on Each Other and Don't Just Sit: The Socialist Legacy, Responsibility, and Winter Risk among Mongolian Herders. *Human Organization, 73*(1), 38–49.

Feeny, D., Berkes, F., McCay, B. J., & Acheson, J. M. (1990). The Tragedy of the Commons: Twenty-two years later. *Human Ecology, 18*(1), 1–19.

Fernandez-Gimenez, M. E., Baival, B., Batbuyan, B., & Ulambayar, T. (2015). Lessons from the Dzud: Community-Based Rangeland Management Increases the Adaptive Capacity of Mongolian Herders to Winter Disasters. *World Development, 68*, 48–65.

Fernandez-Gimenez, M. E. (2001). The Effects of Livestock Privatisation on Pastoral Land Use and Land Tenure in Post-Socialist Mongolia. *Nomadic Peoples, 5*(2), 49–66.

Fernandez-Gimenez, M. E. (1999). Sustaining the Steppes: A Geographical History of Pastoral Land Use in Mongolia. *Geographical Review, 89*(3), 315–342.

Fratkin, E. A. (1997). Pastoralism: Governance and Development Issues. *Annual Review of Anthropology, 26*, 235–261.

Fratkin, E. A., & Mearns, R. (2003). Sustainability and Pastoral Livelihoods: Lessons from East African Maasai and Mongolia. *Human Organization, 62*(2), 112–122.

Gardner, R., Ostrom, E., & Walker, J. M. (1990). The Nature of Common-Pool Resource Problems. *Rationality and Society, 2*(3), 335–358.

Gelcich, S., Guzman, R., Rodriguez-Sickert, C., Castilla, J. C., Cardenas, J. C. (2013). Exploring External Validity of Common Pool Resource Experiments: Insights from Artisanal Benthic Fisheries in Chile. *Ecology and Society* 18(3).

Gerkey, D. (2013). Cooperation in Context: Public Goods Games and Post-Soviet Collectives in Kamchatka, Russia. *Current Anthropology* 54(2).

Gil-White, F. J. (2004). Ultimatum Game with Ethnicity Manipulation: Problems Faced Doing Field Economic Experiments and their Solutions. *Field Methods* 16(2).

Gurven, M. (2004). To give an give not: The behavioral ecology of human food transfers. *Behavioral and Brain Sciences, 47*, 185–192.

Hagen, E. H., & Hammerstein, P. (2006). Game Theory and Human Evolution: A critique of some recent interpretations of experimental games. *Theoretical Population Biology, 69*, 339–348.

Haley, K. J., & Fessler, D. M. T. (2005). Nobody's watching? Subtle cues affect generosity in an anonymous economic game. *Evolution and Human Behavior, 26*, 245–256.

Hardin, G. (1968). The Tragedy of the Commons. *Science, 162*(3859), 1243–1248.

Hilker, T., Natsagdorj, E., Waring, R. H., Apustin, A., & Wang, Y. (2014). Satellite observed widespread decline in Mongolian grasslands largely due to overgrazing. *Global Change Biology, 20*, 418–428.

Humphrey, C., & Sneath, D. (1999). *The End of Nomadism? Society, State, and the Environment in Inner Asia*. The White Horse Press.

Humphrey, C., & Sneath, D. (1996). *Culture and Environment in Inner Asia 1: The Pastoral Economy and the Environment*. The White Horse Press.

Lattimore, O. (1941). *Inner Asian Frontiers of China*. Oxford University Press.

Li, W., Huntsinger, L. (2011). China's Grassland Contract Policy and its Impacts on Herder Ability to Benefit in Inner Mongolia: Tragic Feedbacks. *Ecology & Society* 16(2).

Liu, Y. Y., Evans, J. P., McCabe, M. E., de Jeu, R. A. M., van Dijk, A. I. J. M., Dolman, A. J., Saizen, I. (2013). Changing Climate and Overgrazing Are Decimating Mongolian Steppes. *PLoS One* 8(2).

McCabe, J. T., Leslie, P. W., & DeLuca, L. (2010). Adopting Cultivation to Remain Pastoralists: The Diversification of Maasai Livelihoods in Northern Tanzania. *Human Ecology, 38*, 321–334.

Mearns, R. (1996). Community, collective action and common grazing: The case of postsocialist Mongolia. *The Journal of Development Studies, 32*(3), 297–339.

Mearns, R. (1993). Pastoral institutions, land tenure and land policy reform in post-socialist Mongolia (PALD): A Research and Training Project. Institute of Development Studies at the University of Sussex.

Messick, M., Allison, S. T., Samuelson, C. D. (1988). Framing and Communication Effects on Group Members' Responses to Environmental and Social Uncertainty. In *Applied Behavioral Economics Vol. II,* Edited by Shlomo Maital. New York University Press.

Murphy, D. J. (2018). "We're Living from Loan-to-Loan:" Pastoral Vulnerability and the cashmere-debt Cycle in Mongolia. In Donald C. Wood (Ed.) *Individual and Social Adaptations to Human Vulnerability (Research in Economic Anthropology, Volume 38).* Emerald Publishing Limited.

Murphy, D. J. (2014). Ecology of Rule: Territorial Assemblages and Environmental Governance in Rural Mongolia. *Anthropological Quarterly, 87*(3), 759–792.

Ostrom, E., Dietz, T., Dolsak, N., Stern, P. C., Stonich, S., & Weber, E. U. (2002). *The Drama of the Commons*. National Academies Press.

Ostrom, E., Gardner, R., & Walker, J. (1994). *Rules*. University of Michigan Press.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action (Political Economy of Institutions and Decisions)*. Cambridge University Press.

Purevjaw, G., Balling, R. C., Jr., Cerveny, R. S., Allan, R., Compo, G. P., Jones, P., Peterson, T. C., Brunet, M., Driouech, F., Stella, J. S., Svoma, B. M., & Krahenbuhl, D. (2015). The Tosontsengel Mongolia world record sea-level pressure extreme: Spatial analysis of elevation bias in adjustment-to-sea-level pressures. *International Journal of Climatology, 35*, 2968–2977.

Rapoport, A., Budescu, D. V., & Suleiman, R. (1993). Sequential Requests from Randomly Distributed Shared Resources. *Journal of Mathematical Psychology, 37*, 241–265.

Ruffle, B., Sosis, R. (2007). Does it Pay to Pray? Costly Ritual and Cooperation. *The B.E. Journal of Economic Analysis and Policy* 7(1).

Sneath, D. (2003). Land use, the environment and development in post-socialist Mongolia. *Oxford Development Studies, 4*, 441–459.

Sneath, D. (2002). Mongolia in the Age of the Market: Pastoral Land-use and the Development Discourse. *Markets and moralities: Ethnographies of postsocialism* 191.

Sneath, D. (1993). Social relations, networks and social organisation in post-socialist rural Mongolia. *Nomadic Peoples, 33*, 193–207.

Sosis, R., Ruffle, B. (2003). Religious Ritual and Cooperation: Testing for a Relationship on Israeli Religious and Secular Kibbutzim. *Current Anthropology* 44(5).

Swift, J., & Siurua, H. (2002). Drought and Zud but No Famine (Yet) in the Mongolian Herding Economy. *IDS Bulletin, 33*(4), 88–97.

Swiss Development Cooperation (SDC). (2010). *A Livelihood Study of Herders in Mongolia*. Swiss Agency for Development and Cooperation.

Sznycer, D. (2016). Personal communication regarding zero-sum orientation survey variables in August 2016.

Tachirii, K., Shinoda, M., Klinenberg, B., & Morinaga, Y. (2008). Assessing Mongolian snow disaster risk using livestock and satellite data. *Journal of Arid Environments, 72*, 2251–2263.

Taylor, J. (2012). Constraints of grassland science, pastoral management, and policy in Northern China: Anthropological perspectives on degradational narratives. *Journal of Development Issues* 11(3).

Taylor, J. (2006). Negotiating the Grassland: The Policy of Pasture Enclosures and Contested Resource Use in Inner Mongolia. *Human Organization, 65*(4), 374–386.

Templer, G., Swift, J., & Payne, P. (1993). The changing significance of risk in the Mongolian pastoral economy. *Nomadic Peoples, 33*, 105–122.

Thrift, E. D., Byambabaatar, I. (2015). Management of *dzud* risk in Mongolia: Mutual aid and institutional interventions. *Proceedings of the Trans-disciplinary Research Conference: Building Resilience of Mongolian Rangelands*. Ulaanbaatar, Mongolia, June 9–10, 2015.

UNDP. (2010). UNDP on Early Recovery: 2009–2010 Monoglian Dzud. Retrieved from http://www.undp.mn/publications/Early_recovery.pdf

Upton, C. (2008). Social Capital, Collective Action and Group Formation: Developmental Trajectories in Post-Socialist Mongolia. *Human Ecology, 36*(2), 175–188.

Vernooy, R. (2011). How Mongolian Herders are Transforming Nomadic Pastoralism. *Solutions, 2*(5), 82–87.

Walker, J. M., Gardner, R., & Ostrom, E. (1990). Rent Dissipation in a Limited-Access Common-Pool Resource: Experimental Evidence. *Journal of Environmental Economics and Management, 19*, 203–211.

Wang, Y., Wang, J., Li, S., Qin, D. (2014). Vulnerability of the Tibetal Pastoral Systems to Climate and Global Change. *Ecology & Society* 19(4).

Williams, D. M. (2002). *Beyond Great Walls: Environment, Identity, and Development on the Chinese Grasslands of Inner Mongolia*. Stanford University Press.

Williams, D. M. (1996). The Barded Walls of China: A Contemporary Grassland Drama. *The Journal of Asian Studies, 55*(3), 665–691.

Zukosky, M. L. (2008). Reconsidering governmental effects of grassland science and policy in China. *Journal of Political Ecology* 15(1).