How Community-Based Rangeland Management Achieves Positive Social Outcomes In Mongolia: A Moderated Mediation Analysis

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ABSTRACT

Evidence-based policy guidance necessary for addressing mixed outcomes of community-based rangeland management (CBRM) is limited, dominated by case studies, and lacking coverage of diverse ecological settings. In remedy, we studied 65 traditional neighborhoods and 77 formally-organized CBRM groups across four ecological zones and investigated how and when CBRM obtains greater social outcomes than non-CBRM neighborhoods. We measured pastoralists' social capital, rangeland management practices, and behavior using a mixed-methods approach including qualitative interviews, focus groups, and quantitative questionnaires of 706 herder households. We applied a conditional process analysis method, novel to CBRM studies, to investigate potential mechanisms by which CBRM affects social outcomes.

CBRM members used significantly more information sources, had stronger leadership, more opportunities for knowledge exchange, and rules for resource use, which were significantly associated with greater social outcomes including the use of traditional and innovative rangeland and herd management practices, proactive behavior, and social networking. Access to diverse information sources emerged as an important variable related to strong local leadership, knowledge exchange, and setting rules for rangeland use. Ecological context had a strong association with the level of CBRM social outcomes achieved through this process. The statistical effect of CBRM, mediated by information, leadership, knowledge exchange, and rules, was significantly greater on proactive behaviors of desert steppe herders compared to herders in non-desert steppe zones. Further, CBRM mediated by the same four variables, was associated with higher social networking among herders in the mountain and forest steppe, steppe, and desert steppe but not in the eastern steppe. Our findings suggest why CBRM outcomes have been mixed in Mongolia and elsewhere, and point to the importance of accounting for local context in facilitating development of pastoral institutions. Policies to support CBRM should consider prioritizing resource users' access to diverse information, leadership development, and involvement in elaborating community rules for resource management and local forums for information exchange.

1. Introduction

For the last century, Mongolian pastoralists have experienced several dramatic policy reforms, which substantially influenced institutions governing rangeland use in the country. For millennia, the key function of pastoral institutions has been maintaining a viable balance between pastures, livestock, and people to sustain livelihoods from scarce and variable dryland resources (Agrawal, 1992; Bennett et al., 2010; Koocheki & Gliessman, 2005; Niamir-Fuller & Turner, 1999). Imbalances among these key elements of pastoralism may result in resource degradation and impoverishment of pastoral livelihoods, pointing to institutional failure. In Mongolia, historically, both formal and informal pastoral institutions have coexisted, where formal systems coordinate pasture use patterns and seasonal movements within large-scale territories while informal norms and customs regulate local level resource use (Fernandez-Gimenez, 1999; Undargaa & McCarthy, 2016). Changes in rangeland institutions and management following the transition to democracy and a market economy challenge the sustainability of Mongolia's pastoral economy and rangeland ecosystems. Over 2000 community-based rangeland management (CBRM) groups have formed since 1999 to address this challenge, with mixed outcomes. Here we report on a large sample study comparing formally organized and informal community management of Mongolian rangelands across multiple ecological zones to examine the potential mechanisms through

which CBRM achieves positive social outcomes, and the role of ecological context in conditioning this process. In this introduction we first provide the historical and institutional setting for the emergence of formal CBRM groups in Mongolia and summarize existing research on CBRM, and then outline our specific objectives and hypotheses.

Formal pastoral institutions during Mongolia's socialist collective era (from 1960s till the early 1990s) (Fernandez-Gimenez, 1999; Upton, 2009) succeeded in maintaining "general positive attitudes of herders toward the *negdel* (state collective)" (Goldstein & Beall, 1994) and ecological conditions of rangeland resources by retaining major traditional pastoral practices and strenthening them through education, social services and technology (Fernandez-Gimenez, 1999; Swift, 1995). The socialist reforms in rangeland management included three key changes: land was declared state-owned, livestock was nationalized, and *negdels* were created to manage pastures, herders and livestock (Muller & Bold, 1996). Importantly, the state collectives created a system of social services and supply of basic goods to rural herders through 498 mobile cinema services, 455 *soum* (county) cultural clubs and 404 *soum* libraries, and 2709 mobile shops (Mongolian Academy of Sciences, 1990). Postal services to rural areas delivered major newspapers, journals, and books weekly or daily. Education and human resource systems trained and retrained both herders and professionals by means of informal (national and regional meetings, site training courses, herder forums) and formal education structures (vocational schools, universities for veterinarians, livestock experts, agricultural economists, and training courses for *negdel* managers). All of these services provided essential opportunities for herders to access different sources of information and develop skills and networks, which facilitated the enforcement of regulations set by pastoral institutions.

In the early 1990s, Mongolia adopted economic liberalization policies as part of its transition to a free market and democratic system, starting with decollectivization of the pastoral sector. The privatization of *negdel* assets including livestock led to the influx of new, inexperienced herders to the pastoral sector (Mearns, 1996). With the breakdown of *negdels*, formal institutions for rangeland management collapsed, and the supporting social services (Muller & Bold, 1996; Swift, 1995) were withdrawn. Such policy-driven changes resulted in decreased mobility, increase of the national herd, concentration of livestock in central areas adjacent to markets, changes in livestock species in favor of goats, increasing out-of-season grazing and tresspassing on reserved pastures, and rise in conflicts and mistrust (Fernandez-Gimenez, 2001; Fernandez-Gimenez, 2002; Muller & Bold, 1996; Upton, 2008). These dynamics raised concerns about rangeland resource degradation and calls for non-state institutions to regulate rangeland use in Mongolia (Muller & Bold, 1996; Swift, 1995). Simultaneously, international development agencies urged clarification of land tenure and property rights to incentivize investments in land improvements (Upton, 2009). The situation in the pastoral sector was further exacerbated by major natural disasters (*dzud*) from 1999 to 2002, which harshly hit herders and the entire national economy (Fernandez-Gimenez et al., 2012; UNDP, 2010). Many herders fell into poverty and migrated to urban areas (Nixson & Walters, 2006; World Bank, 2009), indicating that pastoral institutions in post-socialist Mongolia were insufficient to mitigate and manage pastoral risks effectively.

In this context, the Government approved new regulations set in the Land law of 1994 and its revision in 2002, which granted authority to the local government to manage pasture use, seasonal movements and stocking rates (Fernandez-Gimenez & Batbuyan, 2004; Upton, 2009). The key features of these policy reforms included the government authority to issue possession contracts over winter and spring campsites to individual household or *khot ail* (an informal social unit consisting of 2-12 herder households sharing the same campsites) (Fernandez-Gimenez & Batbuyan, 2004). However, policies did not address the restoration of rural social services, leaving herders without access to vital information critical for adapting their livelihood strategies to the new

socioeconomic system. The policy reforms were also ambiguous with respect to property rights over pastureland (Fernandez-Gimenez & Batbuyan, 2004).

Following advice from external experts (Agriteam-Canada, 1997; Swift, 1995; UNDP, 2002), some donor projects began to support community-based natural resource management (CBNRM) in Mongolia (Ministry of Nature and Environment, 2007; Schmidt, 2006) as a potential option to address problems of rural poverty and resource degradation in the absence of strong pastoral institutions. The process of engaging herder communities in resource management expanded from the initial efforts to address the consequences of the *dzud*, to institution-building objectives through devolution of rights to herder groups (Upton, 2009). The first herder community group was established in 1999 in Bayandalai *soum*, Umnugovi *aimag* (province) and its achievements were widely shared among various donor programs (Schmidt, 2005).

According to a UNDP (2006) herder group assessment, in 2006 there were 14 different programs facilitating capacity building of over 2000 herder groups in 19 *aimags*. However, research reported mixed outcomes of CBRM, as has been the case internationally (Agrawal & Chhatre, 2006; Measham & Lumbasi, 2013; Nadasdy, 2003; Saito-Jensen et al., 2010). Some studies found positive outcomes of CBRM in Mongolia (Baival, 2012; Leisher et al., 2012; Upton, 2008), while others documented ineffectiveness (Addison et al., 2013; Murphy, 2011), or called for cautious optimism (Fernandez-Gimenez et al., 2015; Fernández-Giménez et al., 2012). Despite valuable contributions, these studies were limited by small samples and restricted geographic coverage that reduced generalizability. In contrast, the present study used data from 142 pastoral groups across four ecological zones in 10 of Mongolia's 21 *aimags*. Drawing on this unprecedented data set, Ulambayar et al (2017) documented significantly greater social outcomes in CBRM compared to traditional groups (hereafter referred to as non-CBRM groups). In this paper, we investigate underlying processes that link formal organization to desired behavioral, social capital and livelihood outcomes, which we refer to as "ultimate" social outcomes. To do this, we statistically examine the influence of "intermediate outcomes," namely information access, knowledge exchange, leadership and rule-setting, on each other and on "ultimate outcomes," and how these are moderated by geographical context in different ecological zones. We thus ask how different social outcomes occur in two types of nomadic communities in similar social, political and environmental contexts and "when" and "for whom" CBRM works (Wu & Zumbo, 2008). Specifically, we address three main objectives and three hypotheses.

First, previous work has shown that Mongolian CBRM groups have greater ultimate social outcomes (Ulambayar et al., 2017). Specifically, they undertake more traditional and innovative management practices, exhibit more proactive behavior to solve resource issues, and members have more household assets, one indicator of enhanced livelihoods. Our first objective is therefore to investigate whether formal CBRM groups also have higher levels of other factors, such as information access, knowledge exchange, leadership, and rules, which may help explain how and why they achieve greater behavioral outcomes than non-CBRM groups. We refer to these factors as "intermediate" social outcomes, because we theorize that these are necessary antecedents to behavioral and livelihood changes. We hypothesize (H-1) that formally-organized CBRM groups will have greater levels of intermediate social outcomes compared to non-CBRM groups because their commitment to collaborate to improve rangeland resources provides opportunities to access external support from both donor projects and local government (Leisher et al., 2012; Measham, 2007; Taylor, 2009).

Our second objective is to explore the potential mechanisms (Hedström & Ylikoski, 2010) through which formal organization may influence ultimate social outcomes of pastoral groups. We hypothesize (H-2) that these intermediate social outcomes jointly mediate the statistical effect of CBRM on ultimate social outcomes, in line with the

results of prior studies that examined factors contributing to the successful resource management (Agrawal, 2001; Baival, 2012; Fernandez-Gimenez et al., 2015; Ostrom et al., 1994). Specifically, we posit (H-2) that indirect statistical effect of CBRM on ultimate social outcomes will be greater than the direct effect of formal organization alone.

Third, theory and past research indicate that the ecological context may also influence these relationships (Agrawal, 2001; Brooks et al., 2013; Ostrom, 1990). While this may seem obvious, because no large-N studies of rangeland institutions exist, the role of varying ecological context in CBRM outcomes has seldom been studied. Classic common pool resource (CPR) theory suggests that CBRM institutions will be more successful in more productive and less variable environments where CPRs are smaller and easier to bound spatially, and where resource users live in closer proximity to one another (Agrawal, 2001; Baland & Platteau, 1996; Ostrom, 1990; Wade, 1988). In contrast, in highly variable and arid environments, it may be more difficult to spatially delineate resources or socially define user groups, and users are more likely to be widely dispersed and mobile (Fernandez-Gimenez, 2002). Alternatively, cooperation experiments from rangeland regions of southern Africa (Prediger et al., 2011) and Australia (McAllister et al., 2011) suggest that cooperation is greater in more arid and variable or more ecologically sensitive environments. This question is of both practical and theoretical importance because rangeland policies and development interventions, including formally organized CBRM, are often implemented using a one-size-fits-all template approach (Turner, 2011). The question of ecological context is especially timely in Mongolia, where a new national pastureland law has been proposed that would institutionalize herder groups as the holders of collective pasture use rights. Therefore, our third objective is to evaluate how ecological conditions affect social outcomes and the process of achieving them among Mongolian herder groups. We hypothesize (H-3) that ecological zone will moderate intermediate social outcomes, which, in turn, may create supporting or impeding conditions for achieving ultimate social outcomes by community-based institutions.

2. Methods

2.1. Sampling design

We selected 18 pairs of adjacent *soums* (counties) ($N = 36$), across four ecological zones (mountain and forest steppe, steppe, eastern steppe, and desert steppe), with ($n = 18$) and without ($n = 18$) formal CBRM programs (Fig. 1). To select study *soums* we first created a database of all formal CBRM programs in Mongolia and their locations by *soum* and ecological zone. We then identified the three programs with the broadest geographic distribution, largest number of CBRM groups, and which represented the three main organizational types, known as pasture user groups or PUGs, herder groups, and *nukhurlul*. We identified all candidate pairs of adjacent *soums* with similar environmental conditions (e.g. climate, topography, dominant vegetation types) with and without formal CBRM organizations. We purposely selected pairs of *soums* that were best matched on environmental characteristics and which provided a mix of different organizational types in each ecological zone, and eliminated pairs with potentially confounding influences, such as large mines and provincial capitals. Due to logistical constraints, we eliminated candidate pairs in far western and southern Mongolia, focusing on central and eastern Mongolia, where CBRM activity is most widespread and degradation concerns are greatest.

Sampling before and after CBRM establishment was not possible. Therefore, to further control for potential confounding differences between CBRM and non-CBRM sites, we used *soum*-level poverty and leadership indicators and group-level demographic indicators to assess whether CBRM groups had other characteristics that predisposed them to higher social outcomes, and found none (Ulambayar et al., 2017). Selecting matched sites within ecological zones and provinces also reduced potential for pre-existing environmental and governance differences (Ulambayar et al., 2017). The large sample size, representing over 10% of all Mongolia's *soums*, and inclusion of multiple group types across all ecological zones ensures the representativeness of our sample. However, due to the single point in time observational study design, we refrain from causal inferences. Instead, we emphasize statistical associations between variables that measure intermediate and ultimate social outcomes by organization type and ecological zones.

In each *soum* with formal CBRM organizations, the number of CBRM groups ranged from one to 16. Within each study *soum*, we randomly selected an average of five community groups sharing common grazing areas and water sources. In CBRM *soums*, we attempted to sample at least five groups. The actual number sampled ranged from one to 9, with a larger number sampled in *soums* with more CBRM groups. *Soums* in the eastern steppe had fewer CBRM groups, accounting for the low number of groups per sampled *soum* and overall in that region. In non-CBRM *soums* we attempted to sample at least four community groups. We placed greater sampling effort on CBRM *soums* because we wanted a sufficient sample size to compare among different CBRM organizational types. Within each study *soum*, we surveyed an average of five households from each group (range 3 – 7). In total, we surveyed 706 herder households from 142 groups; 65 non-CBRM and 77 formally-organized CBRM groups.
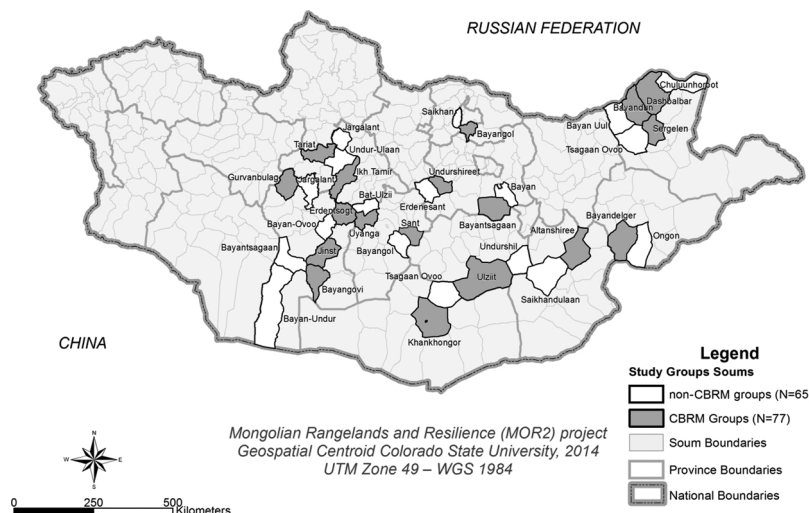

Fig. 1. Study sites located in 36 soums across four ecological zones paired with and without community-based rangeland management (CBRM) programs.

2.2. Data collection

We collected data at household and group levels using household surveys, focus groups, and interviews. We surveyed individual households using quantitative questionnaires measuring household demographics, income and expenditures, management practices and behaviors, trust and social norms and networks. Questionnaires were designed to investigate whether formal organization of herders influenced household-level management practices, socio-economic conditions, and social dynamics. At the group level, we interviewed CBRM and neighborhood group leaders and held focus groups with members. Based on the questionnaires, focus groups and interviews, the survey team created an organizational profile for each group, which represented a synthesis of qualitative and quantitative data about the group's characteristics, activities, leadership, internal governance, and economic well-being. The household questionnaires and organizational profile were the primary data sources of the study. We designed instruments based on prior studies in Mongolia (Baival, 2012; Fernandez-Gimenez, 2002; Fernandez-Gimenez & Batbuyan, 2004; Fernández-Giménez et al., 2012) and followed the guidance of the International Forestry Resources and Institutions protocols for data collection at the community level (IFRI, 2013).

2.3. Variables

We used the following variables (Table 1): a) independent variables: organization type (CBRM vs. non-CBRM) and ecological zone coded as 1 "desert steppe," 2 "steppe," 3 "eastern steppe," and 4 "mountain and forest steppe", b) four intermediate outcome variables, and c) six dependent ultimate social outcome variables as follows: proxies for 1) livelihoods (household assets); 2) cognitive social capital (trust and norms of reciprocity among group members (Putnam, 2000)); 3) structural social capital (bonding and linking social ties (Grootaert et al., 2002)); rangeland practices and herder behavior including 4) traditional rangeland management practices in place during or before collectivization as well as 5) recently introduced innovative management practices, and 6) proactive actions in local rangeland-related issues. Intermediate outcome variables included 1) information sources available to the members, perceptions about 2) leadership including community and local government leaders, 3) knowledge exchange within and outside of the group, and 4) agreed rules for rangeland management among members. Knowledge exchange assessed if the members have someone to consult and exchange ideas with on essential topics of rangeland management. Leadership measured the presence of legitimate local leaders. Lastly, agreed rules indicated the presence of rules for resource management as reported by herders.

In the conditional process analysis, we used the four intermediate outcome variables as mediators (M_{1-4}) and the ecological zone as a moderator variable (C). Our study adopted a definition of a *mediator* as "a third variable that <u>links</u> a cause and an effect" (Wu & Zumbo, 2008, p. 368) or "transmits the effect of an independent variable onto a dependent variable" (Edwards & Lambert, 2007, p. 1). All mediators were continuous variables. A *moderator* was defined as a third variable that <u>modifies</u> a causal effect by strengthening or changing its direction (Wu & Zumbo, 2008) and sets the boundary condition for the effect of X and precedes it (Hayes, 2013). Due to the model software limitations, we used four dichotomous moderators: desert vs. non-desert, steppe vs. non-steppe, eastern steppe vs. non-eastern steppe and mountain and forest steppe vs. non-mountain and forest steppe. We used the conditional process analysis or moderated mediation (Edwards & Lambert, 2007; Hayes, 2015; Preacher et al., 2007) to test if the mediated statistical effect of formal organization on social outcomes varies by the value of a moderator, i.e. ecological zone.

Table 1
Descriptives of Variables Used in the Social Outcome Analysis of Pastoral Groups ($N = 142$).

Variable name	Description	M	SD	Range	Skewness
Independent variables	dichotomous; non-	7.66	1.78	3-13	.30
Organization type	CBRM/CBRM[a]	1.14	.36	0-1.9	-.09
Ecological zone	categorical; four	.59	.34	0-1.5	.51
Dependent variables	ecozone types[b]	.43	.41	0-1.4	.93
Intermediate outcomes:	Sum of 16	6.50	1.12	4-9	-.10
Information diversity[d]	information sources	1.60	.31	.4-2.0	-1.17
Leadership[d,f]	Mean of 4 items	2.16	.82	.5-4.0	.26
Knowledge exchange[d,e]	with 0-2 scales	7.97	1.68	4-13	.06
Rules[c]	Mean of 4 items	3.09	1.77	0.2-9.0	.93
Ultimate outcomes:	on a scale of 0-2	1.47	.83	0-4.0	.56
Livelihood variable:	Mean of 5 types on a				
Assets[d]	scale of 0-2				
Social capital variables:	Sum of 15				
Cognitive social capital[d,g]	household assets				
Structural social capital[d]	Mean of 6 items				
Behavior/practice variables:	Sum of 13 items				
Traditional practices[d]	Sum of 16				
Innovative practices[d]	traditional practices				
Proactiveness[d]	Sum of 19				
	innovative practices				
	Sum of 4 proactive				
	items				

[a] CBRM stands for Community-based Rangeland Management and refers to formally-organized groups and non-CBRM denotes informal or traditional neighborhoods groups.
[b] Ecological zones are coded as: 1 = Desert Steppe, 2 = Steppe, 3 = Eastern Steppe, and 4 = Mountain and Forest Steppe.
[c] Rules is a group level variable coded as 0 = No Rules, 1 = Traditional or Informal Rules, 2 = Formal Rules.
[d] These variables from household survey dataset were aggregated to the organization level by taking the mean value for the sampled households within each organization or neighborhood group.
[e] Knowledge exchange items were coded as 0 = None, 1 = Some (1-3 people) and 2 = Many (3 < people).
[f] Leadership items were coded as 0 = Disagree, 1 = Neutral and 2 = Agree.
[g] Cognitive social capital items were reverse coded as 0 = Agree, 1 = Neutral and 2 = Disagree, where higher values indicate greater social capital.

2.4. Analyses

To explore the mechanisms by which organization type (CBRM, non-CBRM) influences ultimate social outcomes, we used a three-step analysis. First, we tested if intermediate social outcomes differ by organizational type, given ecological zone, using two-factorial ANOVA. Second, we examined whether intermediate outcomes mediate the statistical effect of formal organization on ultimate social outcomes (Ulambayar et al., 2017) and which effect is stronger: direct ($X \rightarrow Y$) or indirect ($X \rightarrow M \rightarrow Y$). For this purpose, we used a serial-multiple mediation model to detect an indirect effect of formal organization on ultimate social outcomes. We chose the serial mediation model (Model 6 in Process macro of SPSS) instead of a parallel type because a partial correlation test holding (X) constant revealed significant correlations among the proposed mediators (Hayes, 2013) as shown in Supplementary Table 1. The serial mediation model measures the direct and indirect effect of X on Y while examining a process in which X influences M_1, which in turn influences M_2 and so forth, concluding with Y as the final result (Hayes, 2013). Fig. 2 shows this model, where intermediate outcomes were placed as mediators (access to diverse information (M_1), local leadership (M_2), knowledge exchange (M_3), and rules (M_4) for resource management) of organization type's (X) statistical effect on ultimate social outcomes. Beforehand, we tested multiple potential sequences of mediators, which resulted in the sequence presented in the model that explained the most variation in our data, as well as being consistent with practical knowledge.

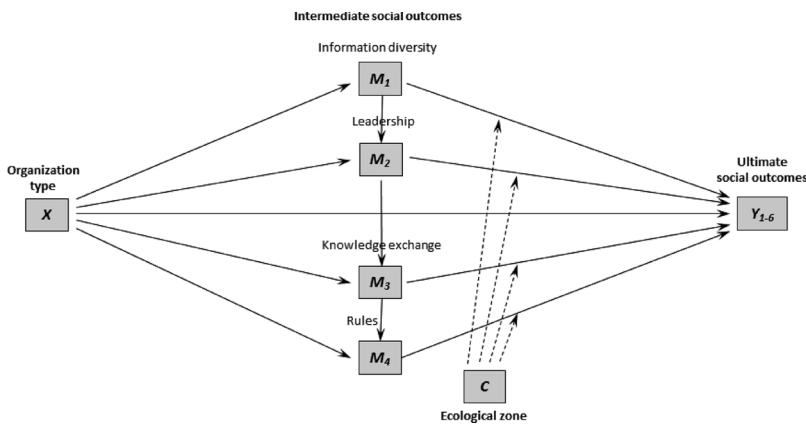Third, we examined if the statistical effect of organizational type on

Fig. 2. Graphic model of the possible influence of organization type on ultimate social outcomes via multiple mediators. Bold lines represent variable's effect on other variables and arrows show the direction of the effect. The diagram depicts a potential serial process in which organization type (X) affects Y through joint effect of Ms (access to diverse information (M_1) local leadership (M_2), knowledge exchange (M_3), rules (M_4) for resource management). Ecological zone (C) moderates the combined effect of mediators (M_{1-4}) on ultimate social outcomes (Y_{1-6}) shown by pecked lines.

ultimate social outcomes mediated by these intermediate outcomes was moderated by ecological zone; i.e., we conducted a moderated mediation test using Model 14 in Process (Hayes, p. 208). In addition to all possible indirect effects between X and Y, the model also shows how ecological zone (C) moderates the effect of mediators (M_{1-4}) on ultimate social outcomes (Y_{1-6}).

A statistical path diagram in Fig. 3 shows three types of direct effects: the organizational type effect on ultimate social outcome variables while holding all mediator variables constant (c'_1); ecological zone on ultimate social outcomes (c'_2); and the interaction effect of organization type and ecological zone on ultimate social outcomes (c'_3). Also, there are five types of specific indirect effects: 1) organizational type - on the mediators (a_{11}, a_{12}, a_{13}, and a_{14}); 2) ecological zone (C) - on each of four mediators (a_{21}-a_{24}); 3) interaction effects (XC) on mediators (a_{31}-a_{34}); 4) mediator variables - on ultimate social outcomes (b_1, b_2, b_3, and b_4) controlling for the effects of organizational type (a_{11}, a_{12}, a_{13}, and a_{14}); and 5) mediators - on one another (d_{21}, d_{31}, d_{32}, d_{41}, d_{42}, and d_{43}). The statistical model for the moderated mediation translates into several linear equations (2.1 – 2.16) shown in Supplementary Table 2.

For the conditional process analyses, we used the PROCESS macro (Hayes, 2013), which offered higher statistical power while releasing normality assumptions for the sampling distribution of indirect effects (p. 106). The PROCESS model for serial-multiple mediators tests the indirect effects using bias-corrected bootstrap confidence intervals[1]. We used 5,000 bootstrap samples for the hypothesis testing, which provided estimates for the total effects, direct effects, and total indirect effects as well as specific indirect effects. The estimations of indirect effects were calculated by multiplying the regression weights corresponding to each step in an indirect pathway (Supplementary Table 2). In this way, we obtained 15 indirect effects (*Ind1-15*) of X on *Ys*. Hence, the total effect was partitioned into the direct effect and the total indirect effect (the sum of all 15 specific indirect effects).

As the PROCESS serial-multiple mediation Model 6 did not have a simultaneous test for the moderation, we ran it separately for those ultimate social outcome variables with a significant mediation effect. We used Model 14, which treated four mediators as parallel controlling their combined indirect effects on dependent outcomes. We ran the moderated mediation test (Hayes, 2015) entering each ecological zone as a dummy variable: desert steppe vs. non-desert steppe etc.

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[1] In bias-corrected bootstrap confidence intervals, "the endpoints are adjusted as a function of the proportion of k values (bootstrap estimates) of ab* (indirect effect of X on Y through M) that are less than ab, the point estimate of the indirect effect calculated in the original data. The adjustments are based on the skew of the distribution k bootstrap estimates" (Hayes, p. 111)

3. Results

3.1. CBRM associated with higher intermediate outcomes (H-1)

Across all ecological zones, CBRM groups had significantly greater information diversity, leadership, and knowledge exchange (Table 2) compared to non-CBRMs. Among these, information diversity had the largest partial eta squared (.14) or practical significance.

We found a significant interaction effect of organizational status and ecological zone on the presence of rules ($F = 6.27$, $p < .01$; Fig. 4). Formal CBRM was strongly associated with greater levels of rules in the three non-desert steppe ecological zones (the effect size was large .21) but not in the desert steppe. Also, the difference in rules across ecological zones was significant ($F = 8.38$, $p < .01$ in Supplementary Table 3) with a large effect size (.16). Herders from the mountain and forest steppe had significantly more rules compared to those in the desert steppe ($\bar{X}_{mount} = .54$ versus $\bar{X}_{desert} = .21$, $p < .01$).

3.2. Intermediate outcomes statistically mediate CBRM effects on ultimate social outcomes (H-2)

Here we report on the results of our exploratory analysis of interrelationships among intermediate and ultimate outcomes. We use the term "effect" here to refer to the statistical effects in our model, rather than to infer causality. We found a significant total effect of formal CBRM jointly with four intermediate social outcomes on traditional and innovative rangeland practices and proactive behavior (Fig. 5). The model had no significant effect on social capital, which was consistent with the prior results (Ulambayar et al., 2017). Unlike these previous results, the model also had no effect on household assets, which statistically could be explained by the addition of the mediating variables into the model that weakened the direct effect of CBRM.

The indirect effect of organizational type on four ultimate social outcomes including traditional and innovative rangeland practices, proactive behavior, and structural social capital was significant. In other words, for the increase in these four ultimate social outcomes, the mediating effect of information diversity, leadership, knowledge exchange, and rules was greater than the direct effect of the formal CBRM. As shown in Fig. 5, CBRM had a significant direct effect only on proactive behavior of members. A closer investigation of the indirect effects (Fig. 6 and Tables 3a and 3b,) revealed that the mediating variables (*bs*) had a stronger influence on ultimate social outcomes than formal CBRM had on the mediating variables (*as*). However, rules were negatively associated with cognitive social capital and assets.

We report all statistical associations among mediators here. Indirect effects of a mediator on other mediators (*ds*) were statistically significant and positive (Table 3a) except for the significant negative association of leadership and knowledge exchange with rules (-.22 and -.28 respectively). We found that information diversity had a consistent
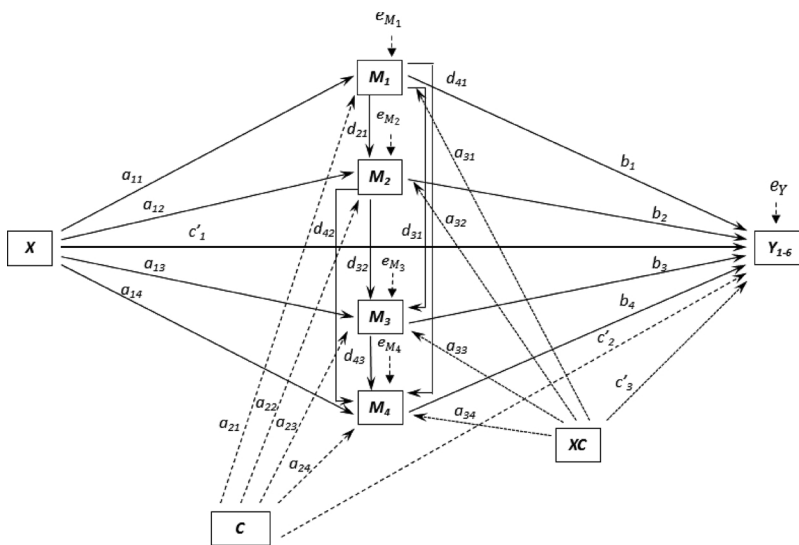
Fig. 3. A statistical path model of Fig. 2 showing the proposed influence of organization type on ultimate social outcomes through multiple mediators. Bold lines represent a variable's effect on other variables and arrows show the direction of the effect. Ecological zone moderates the combined effect of mediators (M_{1-4}) and organization type (X) on ultimate social outcomes (Y_{1-6}) shown by pecked lines. c'_1 is the direct effect of organization type (X) on ultimate social outcomes (Y) holding M_{1-4}; c'_2 is the direct effect of ecological zone (C) on ultimate social outcomes (Ys) holding M_{1-4}; c'_3 is the coefficient of the interaction effect of organization type (X) and ecological zone (C) on ultimate social outcomes (Y) holding M_{1-4}; a_{11}-a_{14} are the specific indirect effects of organization type (X) on each of four mediators (M_1, M_2, M_3, and M_4); a_{21}-a_{24} are the specific indirect effects of ecological zone (C) on each of four mediators (M_1, M_2, M_3, and M_4); a_{31}-a_{34} are the coefficients of interaction effects (XC) on Ms; b_1-b_4 are the specific indirect effects of each mediator (M) on a social outcome variable (Y) holding a_{11-14}; and d_{21} d_{31} d_{32} d_{41} d_{42} and d_{43} are the specific indirect effects of each mediator on the subsequent mediator variable.

Table 2

Results of Two-way ANOVA Showing Main Effect of Organization Type on Intermediate Outcome Variables ($N = 142$).

Variable name	non-CBRM[a]	CBRM[a]	F	p-value	partial η^{2}[f]	R^2
Information diversity [b]	6.82	8.38	21.86	< .01	.14	.24
Leadership[c]	1.02	1.24	8.32	< .01	.06	.15
Knowledge exchange[d]	.48	.68	8.17	< .01	.06	.15
Rules[e]	.26	.58	21.17	< .01	.14	.37

Note. ANOVA tested $Y_{1-4} = X_1 + X_2 + X_1*X_2$ where X_1 is "organization type", and X_2 is "ecological zones", and Y_{1-4} included information diversity, knowledge exchange, leadership and rules. Table shows significantly high means for CBRM groups in these four variables. The test also revealed a statistically significant interaction effect of organization type and ecological zones on rules as shown in Fig. 4.

[a] CBRM stands for Community-based Rangeland Management and refers to formally-organized groups and non-CBRM denotes informal or traditional neighborhoods groups.

[b] Information diversity is aggregated from household data summing 16 information sources.

[c] Leadership is aggregated from household data and coded as 0 = Disagree, 1 = Neutral and 2 = Agree.

[d] Knowledge exchange is aggregated from household data and coded as 0 = None, 1 = Some (1-3 people) and 2 = Many (3 < people).

[e] Rules is aggregated from household data and coded as 0 = No Rules, 1 = Traditional or Informal Rules and 2 = Formal Rules.

[f] Partial eta-squared (effect size) is the proportion of the total variability attributable to a given factor (Karabi, 2012). The effect size is small if $\eta^2 < .50$, medium if $\eta^2 < .80$, and large if $\eta^2 > .80$.

positive association with the other three mediators (d_{21}, d_{31}, d_{41}). Leadership also had a significant positive relationship with knowledge exchange (d_{32}) with the largest R^2. Among the various paths transferring the statistical effect of formal organization onto the four ultimate social outcomes with the significant total effect (Tables 4a and 4b), two were most influential (Fig. 7): the paths through information diversity, and information diversity with leadership. Notably, the path through information diversity alone had a significant positive correlation with all four ultimate social outcomes.

3.3. Ecological zone moderates the mediated effect of CBRM on proactive herder behavior (H-3)

We found a significant interaction between organizational type and ecological zone on the mediation of four intermediate outcomes
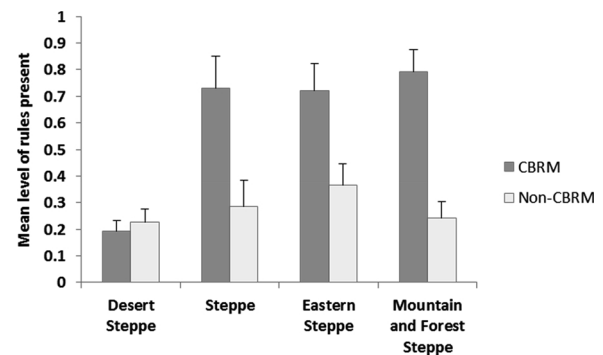

Fig. 4. A visualized significant interaction effect ($p < .01$) of organization type and ecological zone on the presence of rules (F = 6.27, R^2 = .37, partial η^2 = .12). Formal CBRM was strongly associated with greater levels of rules in the three non-desert steppe ecological zones but not in the desert steppe.
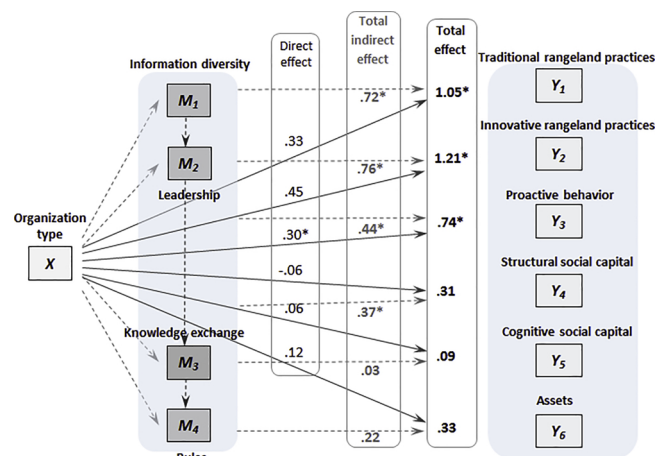

Fig. 5. Potential mechanisms through which organization type influences ultimate social outcomes of pastoral groups. The broken lines show total indirect effects of organization type through serial mediators. The indirect effects on rangeland management practices, proactive behavior and structural social capital were significant. The lines show direct effects of organization type on ultimate social outcomes where only the direct effect on proactive behavior was significant. The total effect (the sum of direct and indirect effects) of organization type through four mediators had a significant association with the increased level of two types of rangeland management practices and proactive behavior of members. The total indirect effects are the sums of 15 specific indirect effects shown in Table 4a and 4b.
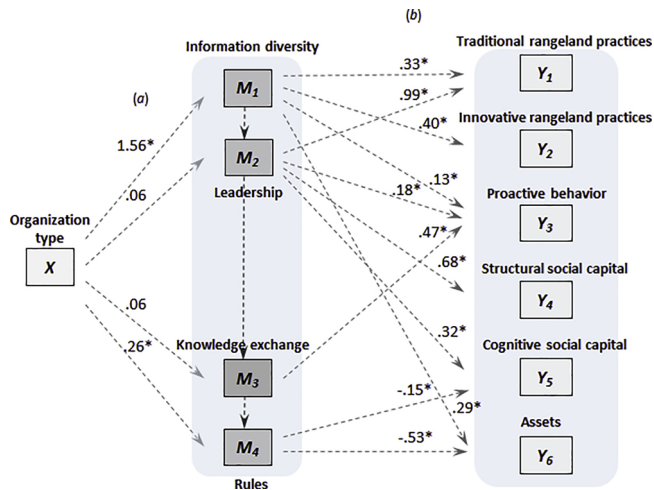
Fig. 6. The significant statistical effects of mediators (*b*s) on ultimate social outcomes prevail in the total indirect effect of organization type on ultimate social outcomes of pastoral groups. The broken lines show all indirect effects of organization type on ultimate social outcomes. a) effects of *X* on M_{1-4}, or *a*s, b) effects of *X* and *M* on *Y*s or *b*s.

(Fig. 8). In other words, the mediated effect of formal CBRM on ultimate outcomes varies depending on ecological zone. Specifically, proactive behavior of CBRM members in the desert steppe zone was 1.19 units higher than the level of those in the non-desert steppe zones (Supplementary Table 4). In contrast, proactiveness of CBRM members in the steppe zone was .60 units less compared to the herders in the non-steppe zones (Supplementary Table 5). Because ecological zone is a dichotomous variable, it simply shows that the increase in proactive behavior was higher among CBRM members in the desert steppe compared to those in non-desert steppe zones, and lower in the steppe zone (with the negative sign). Structural social capital of CBRM members in the eastern steppe was significantly less by 1.82 units compared to those in non-eastern steppe zones (Supplementary Table 6). This implies that formal organization mediated by the four intermediate outcomes, was more weakly related to social networking among eastern steppe herders than in other ecological zones.

We found a significant difference in the moderated mediation test

on proactive behavior only. Note that the moderated mediation or conditional effect is different from the interaction effect reported above. The index of the moderated mediation is the product of the interaction effect of organization type (*X*) and desert steppe ecological zone (*C*) and the indirect effect of rules on proactive behavior, which was ($a_{34}b_4$ = .37) different from zero at 95% CI = .05 to .80 (Supplementary Table 4). This moderated mediation effect implied that CBRM groups differ by .37 units from non-CBRM groups in their proactive behavior given the moderator (desert steppe zone). As reasoned by Hayes (2015 p.2), the evidence of moderation of at least one of the paths in a mediation model is sufficient to claim moderation of mediation. This result supports the hypothesis that the indirect effect of organization type and four mediators on ultimate social outcomes depends on the ecological zone.

4. Discussion

Achieving social outcomes through CBRM is a complex process characterized by the interplay of multiple factors in a local context. Our analysis indicates that increased access to diverse information together with stronger leadership, more knowledge exchange and rule setting, matter more than the mere presence of organized CBRM to improving rangeland management practices, enhancing proactiveness and expanding social networks. Increases in proactive behavior and social networking associated with the indirect effect of intermediate outcomes varied among ecological zones (higher proactiveness in the desert steppe than the steppe or less social networking in eastern steppe than in other three zones), suggesting that regional ecology, geography and cultural differences affect how CBRM outcomes unfold.

We hypothesized that the level of intermediate outcomes would be greater in formally organized groups and our results supported this hypothesis (H-1) in all ecological zones except the desert steppe. In the desert steppe, the lower density of herding households thus less competition for grazing areas coupled with high social capital (Ulambayar et al., 2017) may make setting rules unnecessary and informal norms could be sufficient.

The results support our hypothesis about the mediating effect of intermediate outcomes on ultimate social outcomes (H-2), except that there was no significant indirect effect on assets and cognitive social capital. Together, information diversity, leadership, knowledge exchange, and rules mediated the presence of greater traditional and

Table 3a

Regression Coefficients, Standard Errors, and Model Summary Information for Organization Type Influence on Mediating Intermediate Social Outcomes, Intermediate Social Outcomes' influence on subsequent Intermediate Outcomes, and on Traditional Rangeland Practices through Serial Multiple Mediators or Intermediate Social Outcomes.

Dependent variables																				
Independent		M_1	Information diversity			M_2	Leadership			M_3	Knowledge exchange			M_4	Rules			Y_1	Traditional practices	
variables		Coeff.	SE	p		Coeff.	SE	p		Coeff.	SE	p		Coeff.	SE	p		Coeff.	SE	p
X (OrgType)	a_{11}	1.56	.27	.00	a_{12}	.06	.06	.35	a_{13}	.06	.05	.28	a_{14}	.26	.07	.00	c'_1	.33	.27	.24
M_1(Infodiv)	-	-	-	-	d_{21}	.10	.05	.00	d_{31}	.04	.05	.01	d_{41}	.10	.02	.00	b_1	.33	.10	.00
M_2(Lead)	-	-	-	-	-	-	-	-	d_{32}	.39	.08	.00	d_{42}	-.22	.11	.04	b_2	.99	.42	.02
M_3(KnowExch)	-	-	-	-	-	-	-	-	-	-	-	-	d_{43}	-.28	.11	.01	b_3	.48	.44	.27
M_4(Rules)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	b_4	-.35	.33	.29
Constant		6.82				.33				-.22				-.04			i_Y			.00
		R^2 = .194				R^2 = .286				R^2 = .364				R^2 = .272				R^2 = .353		
		$F(1, 140)$ = 33.62,				$F(2, 139)$ = 27.90, $p < .01$				$F(3, 138)$ = 26.34,				$F(4, 137)$ = 12.81,				$F(5, 136)$ = 14.87,		
		$p < .01$								$p < .01$				$p < .01$				$p < .01$		

Note. c'_1 is the direct effect of organization type (*X*) on ultimate social outcome variables (*Y*) holding M_{1-4}. a_{11}-a_{14} are the specific indirect effects of organization type (*X*) on each of four mediators (M_1, M_2, M_3, and M_4). b_1-b_4 are the specific indirect effects of each mediator on a social outcome variable (*Y*) holding a_{11-14}. d_{21} d_{31} d_{32} d_{41} d_{42} and d_{43} are the specific indirect effects of each mediator on the subsequent mediator variable. Table shows the effects of organization type (*X*) and each mediator variable (M_{1-4}) on subsequent mediators as well as on one of six ultimate social outcomes (traditional rangeland practice). Their effects on other ultimate social outcomes are shown in subsequent Table 3b. Information diversity was the most influential variable with significant positive associations with leadership, knowledge exchange and rules, Leadership had significant positive correlation with knowledge exchange, but negative association with rules. Knowledge exchange also had significant negative relation with rules. Both information and leadership had significant positive relations with traditional rangeland practices. CBRM had a direct positive association with information diversity and rules.

Table 3b

Regression Coefficients, Standard Errors, and Model Summary Information for Organization Type Influence on Behavioral, Social Capital Variables and Assets through Serial Multiple Mediators or Intermediate Social Outcomes.

Dependent variables		Y_2 Innovative Practices			Y_3 Proactiveness			Y_4 Cognitive SC			Y_5 Structural SC			Y_6 Household Assets		
Independent variables		Coeff.	SE	p	Coeff.	SE	p	Coeff.	SE	p	Coeff.	SE	p	Coeff.	SE	p
X (OrgType)	c'_1	.45	.30	.14	.30	.12	.01	.06	.06	.26	-.06	.15	.69	.12	.21	.58
M_1(Infodiv)	b_1	.40	.10	.00	.13	.04	.00	-.00	.02	.91	.08	.05	.12	.29	.07	.00
M_2(Lead)	b_2	.36	.46	.43	.66	.18	.00	.32	.08	.00	.68	.22	.00	.20	.32	.53
M_3(KnowExch)	b_3	.27	.48	.57	.47	.19	.01	.05	.09	.57	.42	.23	.07	-.54	.33	.10
M_4(Rules)	b_4	.02	.36	.96	.03	.14	.86	-.15	.07	.02	.02	.18	.91	-.53	.25	.04
Constant	i_Y	-.77	.60	.20	-.70	.23	.00	1.25	.11	.00	.59	.29	.04	4.55	.41	.00
		$R^2 = .294$			$R^2 = .516$			$R^2 = .230$			$R^2 = .277$			$R^2 = .173$		
		$F(5, 136) = 11.30, p < .01$			$F(5, 136) = 28.94, p < .01$			$F(5, 136) = 8.13, p < .01$			$F(5, 132) = 10.10, p < .01$			$F(5, 136) = 5.70, p < .01$		

Note. c'_1 is the direct effect of organization type (X) on ultimate social outcome variables (Y) holding M_{1-4}, a_{11}-a_{14} are the specific indirect effects of organization type (X) on each of four mediators (M_1, M_2, M_3, and M_4). b_1-b_4 are the specific indirect effects of each mediator on a social outcome variable (Y) holding a_{11-14}, d_{21} d_{31} d_{32} d_{41} d_{42} and d_{43} are the specific indirect effects of each mediator on the subsequent mediator variable. Notably, CBRM had a direct significant effect only on proactiveness. Information diversity and leadership were the most influential variables each associated with increase in three ultimate social outcomes. Knowledge exchange had significant positive correlation with proactiveness only. Rules had a significant negative effect on cognitive social capital and assets.

innovative rangeland practices, proactive behavior, and structural social capital by CBRM groups. For these ultimate outcomes, the indirect statistical effect of the intermediate outcomes was stronger than the direct effect of formal CBRM organization. This result demonstrates that the strong direct association between CBRM and four ultimate social outcomes found in an earlier study (Ulambayar et al., 2017) is explained by the indirect effect of these intermediate social outcomes. This finding sheds light on how CBRM achieves social outcomes, by showing that access to information, knowledge exchange, leadership, and in most zones, rules, may explain greater levels of ultimate outcomes. Consistent with the prior results, there was no mediated total effect of CBRM on social capital variables. Nevertheless, there was a significant indirect effect on structural social capital, which again highlighted the importance of the intermediate outcomes. The lack of the mediated effect of CBRM on household assets may imply that the effect was not statistically strong enough to withstand influences of other covariates.

To understand why rules for rangeland use were negatively associated with trust and norms of reciprocity (cognitive social capital) and household assets, we reviewed the transcripts of focus groups and interviews. We found that some CBRMs adopted rules devised by other groups without adequate discussions to accommodate local specifics or generate real buy-in and "ownership" of the rules by group members. CPR theory and past research have highlighted the importance of resource users' participation in designing and enforcing rules (Ostrom et al., 1994). The degree of ownership of the rules by resource users is considered to be an important factor for success of CBNRM (Measham & Lumbasi, 2013). Moreover, some rules may be perceived to pressure users, undermine trust, and create more conflicts. For instance, in the context of high spatial and temporal variability of resource availability, rules encouraging exclusive access rights to resources with clear boundaries have had negative impacts (Cleaver, 2002; Dyson-Hudson & Smith, 1978; Hogg, 1992), because they may alter essential pastoral strategies of mobility and flexibility to accommodate forage variability across time and space (Behnke et al., 2016; Chen & Zhu, 2015; Turner, 2011). Past research found that exclusive rules of the organized groups in the Mongolian Gobi desert were ineffective (Addison et al.,2012; Fernandez-Gimenez, 2002), and findings from the present study were consistent with this conclusion (Ulambayar et al., 2017). More research is necessary to examine the reasons for the negative influence of rules on social outcomes of pastoral groups in the desert steppe regions of Mongolia. Specifically, it is important to establish what influences the ineffectiveness of rules in the desert steppe. Is it the resource characteristics in this ecological zone, the rule design, the facilitation approach of the external supporters, or a combination of some or all of these factors?

We found that access to diverse information was positively associated with other intermediate outcomes, namely local leadership, knowledge exchange, and rule-setting. The important roles of information access and leadership in the success of CBNRM were consistent with findings of other studies (Constantino et al., 2012; Mountjoy et al., 2014; Waylen et al., 2010). The fact that the path through information diversity alone was more powerful than the path through information diversity together with leadership for both traditional and innovative rangeland practices is worth noting. It suggests that information and training are key for herders to revive proven traditional practices and learn about new innovative methods for resource management. To date herders' need for information and education remains unaddressed in Mongolia (Ahearn & Bumochir, 2016; Chuluunbaatar et al., 2017).

Both leadership and knowledge exchange were negatively associated with the presence of rules. We see three possible explanations for this negative relationship. First, in groups with existing strong leadership and knowledge exchange, well-functioning informal norms may make formal rules unnecessary and possibly counter-productive. Second, local leaders and experienced herders may not support existing

Table 4a

Summary of Total, Direct, and Indirect Effects of Community Organization Type on Behavioral Variables through Serial Mediators.

Dependent variables

Paths		Y_1 (TradPract)			Y_2 (InnoPract)			Y_3 (Proactive)		
		Coeff.	LCI[a]	UCI[b]	Coeff.	LCI[a]	UCI[b]	Coeff.	LCI[a]	UCI[b]
Total effect	c	1.05**	.51	1.58	1.21**	.65	1.77	.74**	.49	.99
Direct effect	c'	.33	-.22	.87	.45	-.15	1.05	.30*	.07	.53
Total indirect effect	$c-c'$	.72*	.35	1.21	.76*	.42	1.34	.44*	.23	.65
Specific indirect effects	a_1b_1	.52	.26	.89	.62	.34	1.00	.20	.08	.34
Ind1: through M_1(Infodiv)	$a_1d_{21}b_2$	.16	.05	.37	.06	-.06	.24	.11	.04	.20
Ind2: M_1 and M_2 (Infodiv, Lead,)	$a_1d_{31}b_3$	.03	-.01	.14	.02	-.03	.13	.03	.01	.09
Ind3: M_1 and M_3 (Infodiv, KnowExch)	$a_1d_{41}b_4$	-.05	-.07	.02	.00	-.10	.12	.00	-.04	.06
Ind4: M_1 and M_4 (Infodiv, Rules)	$a_1d_{21}d_{32}b_3$	.03	-.02	.12	.02	-.04	.09	.03	.01	.07
Ind5: M_1 M_2 and M_3 (Infodiv, Lead, KnowExch)	$a_1d_{21}d_{42}b_4$	.01	-.00	.06	-.00	-.04	.03	-.00	-.02	.01
Ind6: M_1 M_2 and M_4 (Infodiv, Lead, Rules)	$a_1d_{31}d_{43}b_4$	.01	-.00	.03	-.00	-.02	.01	-.00	-.01	.01
Ind7: M_1 M_3 and M_4 (Infodiv, KnowExch, Rules)	$a_1d_{21}d_{32}d_{43}b_4$	01	-.00	.03	-.00	-.01	.01	-.00	-.01	.01
Ind8:M_1 M_2 M_3 M_4 (Infodiv, Lead, KnowExch, Rules)	a_2b_2	.05	-.04	.24	.02	-.02	.18	.04	-.03	.13
Ind9: through M_2 (Lead)	$a_2d_{32}b_3$	.01	-.01	.09	.01	-.01	.06	.01	-.01	.05
Ind10: M_2 and M_3 (Lead, KnowExch)	$a_2d_{42}b_4$	.00	-.00	.04	-.00	-.02	.01	-.00	-.01	.00
Ind11: M_2 and M_4 (Lead, Rules)	$a_2d_{32}d_{43}b_4$	.00	-.00	.02	-.00	-.01	.01	-.00	-.01	.00
Ind12: M_2 M_3 and M_4 (Lead, KnowExch, Rules)	a_3b_3	.03	-.01	.19	.02	-.03	.15	.03	-.01	.10
Ind13: through M_3 (KnowExch)	$a_3d_{43}b_4$	.01	-.00	.06	-.00	-.02	.01	-.00	-.01	.003
Ind14: M_3 and M_4 (KnowExch, Rules)	a_4b_4	-.09	-.30	.05	.01	-.19	.20	.01	-.08	.09
Ind15: through M_4 (Rules)		.36	.04	.73	.56	.24	.98	.09	-.06	.25
Contrast: Ind1 – Ind2										
		R^2 = .097			R^2 = .117			R^2 = .198		
		$F(1, 140) = 15.06, p < .01$			$F(1, 140) = 18.50, p < .01$			$F(1, 140) = 34.64, p < .01$		

Note. c' is the direct effect of organization type (X) on ultimate social outcome variables (Y) holding M_{1-4}. a_1-a_4 are the specific indirect effects of organization type (X) on each of four mediators (M_1, M_2, M_3, and M_4). b_1-b_4 are the specific indirect effects of each mediator on a social outcome variable (Y) holding a_{1-4}. d_{21} d_{31} d_{32} d_{41} d_{42} and d_{43} are the specific indirect effects of each mediator on the subsequent mediator variable.
Table shows the significant total effect of CBRM through serial mediators on three ultimate social outcomes illustrated in Fig.4.
[a] LCI stands for Lower Confidence interval for 95% bias-corrected bootstrap confidence interval.
[b] UCI stands for Upper Confidence Interval for 95% bias-corrected bootstrap confidence interval. *and ** unstandardized coefficient is significant at the 0.05 and 0.01 level respectively.

Table 4b

Summary of Total, Direct, and Indirect Effects of Community Organization Type on Social Capital Variables and Assets through Serial Mediators.

Dependent variables

Paths		Y_4 (CognSC)			Y_5 (StrucSC)			Y_6 (Assets)		
		Coeff.	LCI[a]	UCI[b]	Coeff.	LCI[a]	UCI[b]	Coeff.	LCI[a]	UCI[b]
Total effect	c	.09	-.01	.19	.31	.03	.58	.33	-.04	.70
Direct effect	c'	.06	-.05	.17	-.06	-.35	.25	.12	-.29	.53
Total indirect effect	$c-c'$	.03	-.05	.12	.37	.18	.61	.22	-.01	.50
Specific indirect effects	a_1b_1	-.00	-.06	.05	.12	-.03	.27	.45	.24	.74
Ind1: through M_1(Infodiv)	$a_1d_{21}b_2$	.05	.02	.10	.11	.04	.23	.03	-.06	.17
Ind2: M_1 and M_2 (Infodiv, Lead,)	$a_1d_{31}b_3$	.00	-.01	.02	.03	.01	.09	-.04	-.12	.00
Ind3: M_1 and M_3 (Infodiv, KnowExch)	$a_1d_{41}b_4$	-.02	-.05	-.00	.00	-.07	.06	-.08	-.18	-.01
Ind4: M_1 and M_4 (Infodiv, Rules)	$a_1d_{21}d_{32}b_3$	.00	-.01	.02	.03	.00	.07	-.03	-.11	.00
Ind5: M_1 M_2 and M_3 (Infodiv, Lead, KnowExch)	$a_1d_{21}d_{42}b_4$	.01	.00	.02	-.00	-.02	.02	.02	.001	.06
Ind6: M_1 M_2 and M_4 (Infodiv, Lead, Rules)	$a_1d_{31}d_{43}b_4$	.002	.0001	.01	-.00	-.01	.01	.01	.001	.03
Ind7: M_1 M_3 and M_4 (Infodiv, KnowExch, Rules)	$a_1d_{21}d_{32}d_{43}b_4$	.003	.00	.01	-.00	-.01	.01	.01	.001	.03
Ind8:M_1 M_2 M_3 M_4 (Infodiv, Lead, KnowExch, Rules)	a_2b_2	.02	-.02	.07	.04	-.02	.15	.01	-.02	.12
Ind9: through M_2 (Lead)	$a_2d_{32}b_3$	.00	-.00	.01	.01	-.00	.06	-.01	-.06	.01
Ind10: M_2 and M_3 (Lead, KnowExch)	$a_2d_{42}b_4$	.00	-.00	.01	-.00	-.01	.01	.01	-.00	.04
Ind11: M_2 and M_4 (Lead, Rules)	$a_2d_{32}d_{43}b_4$	.00	-.00	.01	-.00	-.01	.00	.00	-.00	.02
Ind12: M_2 M_3 and M_4 (Lead, KnowExch, Rules)	a_3b_3	.00	-.00	.03	.02	-.01	.12	-.03	-.17	.01
Ind13: through M_3 (KnowExch)	$a_3d_{43}b_4$	.00	-.00	.01	-.00	-.01	.01	.01	-.00	.05
Ind14: M_3 and M_4 (KnowExch, Rules)	a_4b_4	-.04	-.10	-.00	.01	-.10	.12	-.14	-.31	-.02
Ind15: through M_4 (Rules)		-.05	-.14	.02	.01	-.22	.17	.42	.17	.74
Contrast: Ind1 – Ind2										
		R^2 = .022			R^2 = .035			R^2 = .022		
		$F(1, 140) = 3.15, p < .01$			$F(1, 136) = 4.90, p < .01$			$F(1, 140) = 3.15, p = .05$		

Note. c' is the direct effect of organization type (X) on ultimate social outcome variables (Y) holding M_{1-4}. a_1-a_4 are the specific indirect effects of organization type (X) on each of four mediators (M_1,M_2,M_3, and M_4). b_1-b_4 are the specific indirect effects of each mediator on a social outcome variable (Y) holding a_{1-4}. $d_{21}d_{31}d_{32}d_{41}d_{42}$ and d_{43} are the specific indirect effects of each mediator on the subsequent mediator variable.
[a] LCI stands for Lower Confidence interval for 95% bias-corrected bootstrap confidence interval.
[b] UCI stands for Upper Confidence Interval for 95% bias-corrected bootstrap confidence interval.

resource rules, possibly for the reasons speculated earlier; lack of participation in rule development and resulting lack of buy-in. Finally, the facilitation approach may have been inappropriate to ensure active participation and commitment of the local leaders, who are the key stakeholders in local resource management. Further investigation of the local processes of rule setting is needed to fully understand the negative
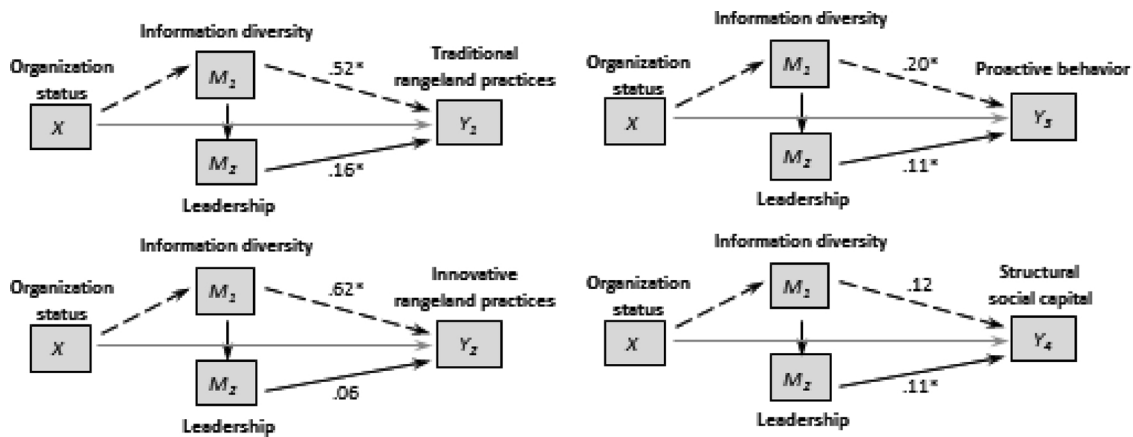
Fig. 7. The two most influential mediating paths that transfer the effect of organization type onto four ultimate social outcomes, where the path through information diversity was the most important. Dashed lines represent the path going through information diversity alone. Solid gray lines represent the second influential path through information diversity and leadership jointly. Unstandardized coefficients are shown at $p < .05$ indicated by asterisks.

relationship between formally agreed-upon rules, leadership, and knowledge exchange in these cases.

Our final hypothesis about the moderation effect of ecological zone on ultimate social outcomes through intermediate variables was supported (H-3). Two of four ultimate social outcomes, proactive behavior and social networking (structural social capital), had a significant interaction effect. As shown, the suite of four mediators is positively associated with both traditional and innovative rangeland management practices of CBRM groups across four ecological zones. These four mediators are also positively correlated with proactive actions and social networks but at different levels due to local cultural, geographical or ecological contexts in diverse ecological zones. Ulambayar et al. (2017) found no interaction effect between CBRM status and ecological zone on ultimate social outcomes. This implied that the significant difference in ultimate social outcomes between CBRM and non-CBRM households was consistent across all four ecological zones. The presence of the significant moderation effect found in this study further clarified that ecological zone also contributed to the variations in the levels of the two ultimate social outcomes. Pronounced differences in the desert steppe and steppe zones in two ultimate outcomes suggest that more nuanced policy solutions are needed to encourage proactive behavior and social networking in CBRM organizations. For instance, the greater level of social capital among desert steppe groups may explain greater proactive behavior, which in theory would make it easier for group members to agree upon rules that meet their needs. As suggested above, if members designed their own rules, theory dictates there would be greater ownership and commitment to enforce the rules. Members'

experience of enforcing those rules could encourage them to bring issues to local authorities and suggest changes in current pasture use arrangements. In contrast, the negative moderation of the steppe ecological zone on the same indirect effect may indicate a weaker ownership of rules. The revealed interaction effect on these two outcomes, when four mediators are added, may imply that the process for producing intermediate outcomes has to better account for local specifics. The significant index of moderated mediation provided more direct and conclusive evidence of moderation of the indirect effect of CBRM by ecological zone than did a test of moderation of one of its paths i.e. interaction effect. To clarify policy implications of this finding, further research is necessary to identify how differences in geography and ecology influence local norms, herders' behavior, and social networking.

5. Conclusions and Implications

Several policy implications for rangeland management emerge from this study. First, facilitation efforts and policy incentives for CBRM development should consider prioritizing providing information and training to herders early on. When access to information and training is limited (as shown by the case of the non-CBRM control groups), it may be difficult to achieve required levels of leadership and knowledge exchange to proceed with rule-setting arrangements for resource management. As discussed in the introduction, the strong system of education and human resource development during the collective era was a key instrument for pastoral institutions to maintain the sustainable
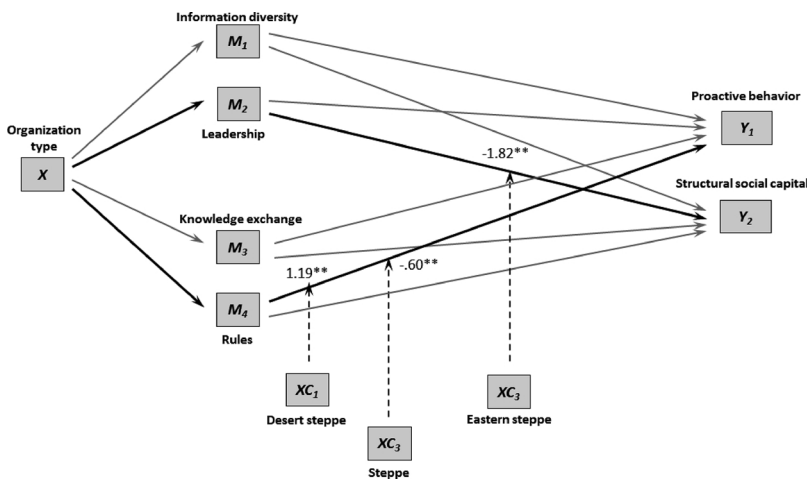

Fig. 8. A significant interaction between organization type and ecological zone with two intermediate social outcomes (solid lines). Desert steppe had a significant positive moderation (broken line) of the indirect effect of the organization type on proactive behavior of members through rules. A negative conditional indirect effect (broken lines) of eastern steppe and steppe zones on proactive behavior and structural social capital through leadership and rules implied a weaker effect compared to non-eastern steppe and non-steppe ecological zones. Unstandardized coefficients are shown at $p < .05$ indicated by two asterisks.

balance between pastures, livestock, and people. In addition, the authoritarian style of *negdel* (collective) management undoubtedly contributed to the enforcement effectiveness. In the current context, information access is a key variable associated with social outcomes with CBRM, an evolving institution in Mongolian pastoralism. Unfortunately, the current government system for education and professional development has yet to effectively address the learning needs of mobile herders. Formally organized CBRM groups are filling this gap for their members, and achieving positive social outcomes, which our analysis suggests could be due to their role in facilitating information access for herders. To assure future sustainability of rangelands and pastoral livelihoods, similar access to education and information should be available to all herders.

Second, policies and programs that aim to facilitate CBRM should consider both intermediate and ultimate social outcomes, and how they are related. With adequate policy incentives and capacity-building efforts, intermediate outcomes of CBRM may be achieved relatively quickly. However, producing more complex ultimate social outcomes, including changes in practices and behaviors, social capital, and livelihoods, may only be possible through these intermediate outcomes. Improved social outcomes contribute to well-functioning pastoral institutions. These institutions, in turn, may be necessary to improve ecological conditions on Mongolian rangelands.

Lastly, the potential influence of ecological zone on social outcomes suggests that national-level CBRM policies should remain general and provide guiding principles and an enabling environment, allowing flexibility for pastoral institutional arrangements to accommodate specifics of local geography, ecology, and culture.

Our results highlight the importance of access to information as a key mechanism through which CBRM influences ultimate outcomes. Past reports showed that adequately delivered information, training, and awareness raising encourages local leaders and inspires action (Schmidt, 2005; Schmidt et al., 2009; UNDP, 2008; Usukh et al., 2010). The precise sequence through which the intermediate outcomes influence ultimate outcomes remains to be determined, but we reason that information sharing is likely an early step in a process that leads to strengthening leadership and eventually to setting rules. Potentially, many shortcomings of CBRM in Mongolia may be associated with neglect of a stepwise capacity-building process. For example, such errors may include meeting the influential leaders first, attempting to set or impose rules first, or organizing local discussions without providing sufficient introductory information to all involved.

This study contributes to commons theory by identifying potential underlying mechanisms for the positive relationship between formal organization of resource users and increased social outcomes. It shows that without intermediate outcomes, formal organization alone is not sufficient to achieve ultimate social outcomes. Information access is especially critical to fostering social outcomes of Mongolian pastoral institutions (Baival & Fernández-Giménez, 2012). Without adequate social capital, it may be difficult to achieve more complex social and ecological outcomes like improved livelihoods and better resource conditions. Hence, in the pastoral context, the pace of progress seems to be important. The groups under study had an average five-year experience of collective action and could achieve outcomes related to daily rangeland practices and collective action for rangeland matters. More time and experience may be required to revitalize trust among the resource users and strengthen reciprocal relationships than the average of five years.

Further, this study deepened our understanding of how resource characteristics shape commons institutions. The fact that two ecological zones had a different effect on the same mediation path showed "when" and "for whom" this mediation works. Based on these findings, we propose that CBRM has produced mixed results in the past due to the lack of understanding among those facilitating CBRM about 1) mediating factors for achieving desired social outcomes, and 2) how these relationships vary with local context.

Finally, this study calls for further research to define potential influences of facilitation approaches on social outcomes of formally organized groups. For example, we recommend qualitative inquiry to elucidate why rules are negatively associated with social outcomes of some pastoral groups, and why local leadership and knowledge exchange are negatively associated with the presence of rules. We also call for more longitudinal data to understand the sequence of intermediate outcomes critical for CBRM social outcomes. Lastly, a closer look at specific governance processes within community groups in different ecological zones would help explain differing levels of social outcomes across four ecological regions.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2018.11.008.

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