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Co-design of transformative research for rangeland sustainability

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Rangelands, home to herders, grazed by livestock and wildlife and, defined predominately as grasslands, comprise approximately 40% of the earth's terrestrial land surface. Rangeland social–ecological system resilience is urgent in many regions under climate, land use, political, market, and demographic changes. Focused on community-based natural resource management collaboratives, researchers and practitioners from Kenya, Mongolia and the US West, gathered to develop a research-for-action project. Using a conceptual framework for development of transdisciplinary global change research a project was co-designed to address natural resource problems to help build resilience in collaborative organizations under change. Participants designed a research agenda and conceptualized a knowledge network. The co-design process showed the common visions of this group from around the world while also demonstrating the actual untidiness of development of transdisciplinary research involving diverse participants.

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Research challenge and framework

Rangelands, home to primarily herders, grazed by livestock and wildlife and, defined predominately as grasslands, comprise approximately 40% of the earth's terrestrial land surface and directly or indirectly provide livelihoods for millions of people [1••]. Rangelands are home to vibrant but often beleaguered pastoral and ranching cultures as well as important but imperiled grassland, steppe, savanna and alpine ecosystems. A central question facing these social–ecological systems (SESs) today is how to maintain system resilience and build capacity to adapt to multiple interacting forces that operate across scales [2–4].

Rangelands are undergoing unprecedented changes worldwide [1••,2,5–7]. Rangelands are being converted to towns and croplands as human populations and consumption grow [8]. Shifting market incentives encourage different livestock strategies away from subsistence and local market production to commercial livestock products, which may or may not be economically or environmentally sustainable. Mining, oil and gas extraction and renewable energy production are expanding into rangelands at a rapid rate, transforming landscapes, communities and rural cultures. As pastoralists settle, formerly communal rangelands are being privatized and subdivided into small parcels [6,9]. These fragmented and often fenced landscapes make it difficult or impossible to move livestock in response to climate variability [10]. Warmer temperatures, changing rainfall patterns and more extreme weather events are creating new challenges for all rangeland ecosystems and human communities [11,12]. Some are areas of poverty relative to others within their countries, while most rangelands are relatively remote [1••,12]. While change is not new to these SESs, the rate and magnitude of change of these complex and interacting forces is making adaptation difficult and threatening system resilience. Social–ecological resilience to these changes has never been more urgent in our regions of focus, Kenya, Mongolia and the US West [5].

Yet, some of these same changes are creating a unique moment in which to leverage transitions to a more sustainable and equitable future for rangeland people and landscapes [1••,6]. Recent political and economic transitions, coupled with changing markets and population shifts create an unprecedented opportunity to respond and adapt to changing climate, land-use and development

trajectories by creating or strengthening community-based and locally adapted rangeland co-management institutions (the formal and informal norms, rules, policies and patterns of interaction that structure human interactions and actions on the land) [13–15]. Collaboratives in each of these regions are governed by both ecological (what the land is capable of producing) and societal considerations [3]. These community groups are called by many different names around the world (e.g. herder groups, community based natural resource organizations, land trusts). In this paper they are jointly referred to as collaboratives.

Kenya's 2010 constitution and devolution of government to new counties mean that natural resource management is in the hands of local institutions that may be able to focus on transformation [1••,16]. Mongolia has a relatively new democratic government and is considering major revisions to laws governing rangeland use and management. In addition, since 1999, over 2000 community-based natural resource management herder groups have been formed by herders in Mongolia to halt degradation, improve livelihoods, and enhance capacity for pastoral risk management [14,15]. In the US Great Plains, American Indian tribes are planning for sustainable wind development [17], while ranchers experiment with market-based conservation incentives and institutions [18]. Bison, which were historically the predominant grazers in the Great Plains, are making a resurgence in the region. For the indigenous peoples of the Great Plains, bison are both culturally and economically important, and they may also be better suited to climate change than introduced cattle [19].

A group of researchers and practitioners from these regions gathered in a workshop to co-design a knowledge-for-action project. The participants have had long-term research and engagement partnerships with one another in the three countries. However, until the workshop, none of the country communities had ever come together to develop a co-designed research initiative involving all three countries.

A framework for transdisciplinary co-creation of knowledge production

Addressing complex problems requires a transdisciplinary approach to research-for-action to support adaptation and transformation. Inclusive approaches are becoming more prevalent with the knowledge that land managers need information in both formal and informal forms and in site-specific ways [20–22]. There are now several frameworks for addressing these types of complex problems with examples of developing and conducting research with use of the frameworks (e.g. [23••]). All frameworks agree that transdisciplinary research is problem-focused rather than discipline-focused, has an evolving methodology and collaboration [24–26] and, often involves non-academic actors [27]. Transdisciplinary global change research co-design is addressed in this paper with use of the framework developed by Mauser *et al.* [28], an integrated framework for global change research. It was created as a result of an ISCU-ISSC Earth System Visioning process [21] and a workshop on Integrated Global Change Research. Figure 1 is adapted from their framework's three different facets of integration: co-design, co-production and, dissemination of results. We were funded by the ISSC initiative on Social Transformations to Sustainability, which followed the ISSC's 'Transformative Cornerstones of Social Science Research for Global Change' report [29••].

This paper focuses primarily on the co-design process, that component in red in Figure 1 but, as will be seen, it addresses all components of the Framework. Co-design in Figure 1 is integral to transdisciplinary research during which research questions emerge from a Joint Framing by all stakeholders. Stakeholders have diverse knowledge systems that can contribute to the problem and Research Definition and it can serve to legitimate further knowledge generation [30••,31]. Implementation of the research is co-designed into proposal development, reviews, etc. The second component of the transdisciplinary approach is Co-Production. This consists of Scientific Integration of interdisciplinary approaches and ensuring Relevance. Relevance is created through the exchange and communication of knowledge between producers and users of knowledge and there is an interactive dialogue between Scientific Integration and Relevance. The last component in the framework is Co-Dissemination of Results in scientific journals but also in forms that are usable by different stakeholders. The overall process is iterative and involves reflection by all the participants in each of the processes.

The workshop process to co-design a research-for-action project

The workshop goal was to co-design a research-for-action research project. There were no pre-conceived notions of the common problems, the research questions and, what methodologies to use and by whom. The research-for-action co-design challenge was first to develop common topics for research among participants from three countries. The workshop was organized by facilitators to have the participants engage in a set of tasks and actions. Graphic recording of the dialogic processes occurred during the course of the workshop [32,33].

The workshop developed common ground and co-designed research for the rangeland SESs among a diverse group. The first step was to create an appropriate tone for the workshop to allow for and acknowledge cross-cultural, cross-sector, and cross-discipline differences [34]. It helped to build trust and foster a learning community. The term, container-building, is commonly used to