MONGOLIA'S NOMADIC WEATHER READERS

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Mongolian herders are moving from season to season, always dependent on the weather. Their livelihoods depend on the sound management of livestock and the natural resources that sustain their animals. Following the transition from a Soviet-dominated regime to democracy and a free market economy accompanied by a reduction of State presence in many domains, Mongolian pastoral livelihoods have become much more exposed to three interrelated forces: natural resource degradation in particular of grasslands and water, rapid societal change, and climate change (Vernooy 2011). One form of adaptation to changes in livelihoods is known as co-management in which herder groups together with government agencies work together to manage the natural resources in a better way . This kind of cooperation has increased herders' capacity to gain more from their resources while avoiding major setbacks (Ykhanbai 2010). However, herders continue to be challenged by weather vagaries and calamities. In particular, extremely cold winters known as *dzud*, cause major havoc. The last *dzud* occurred in 2010 when temperatures varied from minus 35 to minus 50 degrees Celsius (see Box 1). Livestock was completely deprived from natural grass; more than 9 million animals died that winter, about 20% of the national herd. The *dzud* took many herders as a surprise.

Early warning information in the form of weather forecasts that are community specific can assist herders to make better informed and less risk prone decisions concerning their every day livelihoods. These forecasts could also mitigate against the *dzuds* and of reduction of ex post *dzud* recovery efforts and expenditures, which, in recent decades have been enormous for Mongolia (Vernooy and Erdenechuluun 2011). Until 2010, however, Mongolia did not have such a localized weather forecasting system. NAMEM, Mongolia's National Agency for Meteorology and Environmental Monitoring, provides forecasts up to the *sum* (district) level through TV and radio channels, but does have the capacity to provide community level forecasts. There is wide variability of community level conditions due to the mountainous terrain in many regions, with marked temperature, rain and snow fall and wind speed differences. Herders for long have expressed the need for more localized weather information.

Box 1: Recent weather in Mongolia

Following the disastrous *dzud* of 2009-2010, the country experienced more regular winters which allowed herders to recover from the losses. The last *dzud* affected 770,000 herders of which 43,500 were left without a single animal and 164,000 lost more than half of their livestock (Sternberg 2010; United Nations Mongolia Country Team 2010). Many households lost up to 80% of their animals. In normal years, the percentage is around two. Previous *dzuds* occurred in 1999-2000 and 2000-01, killing three million animals equivalent to ten per cent of the total herd in 2000 and another twenty-five per cent of the total surviving herd in 2001. Since 2010, To recover from the last disastrous *dzud* of 2009-2010, still fresh in the memories of most Mongolians, the Mongolian government requested international donor agencies to provide 18.15 million US $ in the form of emergency and post-*dzud* recovery support. The government itself allocated more than 4 million US $ during the winter months (UN Mongolia country team 2010).

Herds across the country have increased rapidly, from 32.7 million in the summer of 2010 to 36.3 million in the summer of 2011 (National Statistical Office of Mongolia 2012). According to herders interviewed across the country, the 2011-2012 winter was regular, but the spring of 2012 was very cold and many animals suffered as a result. Fortunately, the summer of 2012 was very wet contributing to abundant availability of grass and steady recovery of animal weight. *Dzuds* are recurring events in Mongolia, but they appear to occur more regular in the last decades. Impacts are always devastating, but more so when winter preparations have been deficient.

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Generating useful localized weather forecasts for a nomadic lifestyle

Some researchers and meteorologists working in Mongolia had been thinking for some time how to respond to the herders' demand, but had not been able to come up with a concrete proposal. That changed when an opportunity arose for the team , as Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) based in Bangkok, Thailand supports the idea. In 2010, the three put together a team of researchers, meteorologists and herders led by our non-government organized known as JASIL, joining forces in a pilot project to do something about the lack of localized weather forecasting. Based on a tripartite agreement among JASIL, NAMEM and RIMES, the latter committed to provide, through daily email transfers, location-specific weather forecasts (for an area of 9 by 9 kilometers) for a number of pilot sites in Mongolia.[i] The team began to test the hypothesis that information and communication technologies (ICTs) can play an important role in agricultural production and increase rural livelihood resilience through improved risk management at the household and community levels. The team focused on three interrelated aspects: the effective use of ICTs for development; the production of useful localized weather data; and the improvement of herders' livelihoods.

Research and pilot testing were carried out in three pilot study sites building on a decade of previous efforts (Ykhanbai 2010, Vernooy 2011): Ikhbulag community of Khotont *sum* (administrative district) of Arkhangai *aimak* (province), representing the steppe-forest ecosystem, Karatau community of Deluin *sum* in Bayan-Ulgii *aimak*, representing the mountain and steppe dry ecosystem, and Aduunchuluun community of Lun *sum* in Tuv *aimak*, representing the steppe and prairie ecosystem.

In October 2010, the team initiated the process of introducing their plan at the *sum* and community levels starting in Ikhbulag community of Khotont *sum* followed by Aduunchuluun community (Lun *sum*) and Karatau community (Deluin *sum*). The team carried out a needs assessment among herders in the three sites to identify in a precise way how to most effectively set up the new system. Ikhbulag community members were the first ones to identify locally adapted weather forecast needs. They did this according to the regular annual schedule of nomadic lifestyle tasks to be carried out which follows a similar pattern across the country (see table 1). They also identified the main weather variables of interest which are temperature, precipitation and wind speed; a daily frequency of three time intervals; a simple format of forecast reporting. They then discussed and agreed upon the intended use of the weather forecasts, the recording of own weather data (type, frequency, format), and the monitoring activities of the effectiveness of the new weather forecasting system. Herders in all three sites ranked forecasts of three days lead time and a frequency of three recordings per day as the most valuable. Considering all of their deliberations, community members then agreed upon a division of tasks and a work plan for a one year trial period. Three days lead forecasts are the basis for herders' planning of everyday pasture management and livelihood activities. These short-term forecasts complement many traditional forms of longer-term forecasting based on observations of nature, for example, of animals on the steppe. When marmots use lots of hay to build their winter home, building what appears like a tomb, the prediction is that there will be heavy snowfall.

Table 1: Herders' forecast requirements in terms of lead time (Ikhbulag community)

Livelihood activity	**Timing**	**Lead time of forecast**
Preparing hay and fodder	Augustus-September	5 days
Moving with livestock to autumn camp	August 20	5 days
Fixing and building (new) fences	September-October	5 days
Moving with livestock to summer camp	July-September	5 days
Harvesting vegetables	September	5 days
Picking fruits and herbs	August	5 days
Preparing fuel and firewood	October	Several days
Moving to winter camp	November	3 -5 days
Prepare and repairing the animal shelters	November	3 -5 days
Warming up the *ger*	November	3 -5 days
Preparing winter meals	December	3 -5 days
Prepare for Tsagaan Sar (White Moon) festival	February	3 -5 days
Celebrating Tsagaan Sar	February	1 - 3 days
Preparing for the arrival of baby animals	February-March	5 days
Receiving baby animals	March 26 – June	1 - 3 days
Combing goats and cattle	May	1 - 3 days
Shearing sheep wool	July	1 - 3 days
Preparing dairy products	June-September	Several days
Shearing lamb wool	August 20	1 - 3 days
Making felt	August-September	1 - 3 days

Source: JASIL, First technical project report, August 2011.

The new forecast system

Mobile phones have a limited range in Mongolia and transmission is weather dependent. Outside the capital, connection to internet from a cellphone is not yet feasible. One herder from Ikhbulag remarked after the 2009-2010 *dzud*: "During the last dzud, we could not contact the sum governor or anyone else and ask for help. Our mobile signal is very limited. In some areas, only on the highest mountain top is there a signal but in winter we are not able to climb up." (Vernooy and Wang 2010). After careful consideration of ICT possibilities, the annual calendar of herder movements, local geographic conditions, the team designed the first locally adapted data transmission set ups. For each of the three pilot sites, a particular set up was designed and tested. The team studied an earlier example of an ICT-system set up in the Gobi region and made good use of its lessons learned (Wang and Vernooy 2011). Notably, the team adopted the use of a single fixed phone to serve as a community-level transmission "station."

Once a day, in the morning around 9am, RIMES' 3 days weather forecasts travel by email from Bangkok, Thailand, to the NAMEM and to JASIL offices in Ulaanbaatar. Forecasts are given for 8am, 14pm and 20pm, hours indicated by herders as being the most useful in terms of every day decision making of their herding activities. From there, the data are transmitted to the sites using email in the case of Lun and phone in the case of Khotont; for sites, back-up group messaging was also used. For Deluin, group messaging from the JASIL office was used as the only viable alternative. In the case of Deluin, where local transmission is more difficult due to the high mountains, the RIMES data were transferred from the JASIL office in Ulaanbaatar by group SMS system (using G-mobile) directly to herders in Deluin, to the *sum* governor's office, and to the NAMEM office. In the cases of Lun and Khotont, the data go to the NAMEM office/station in the *sum* centres, and from there by telephone to a focal or nodal weather herder in the pilot communities equipped with a fixed phone. The focal weather herder uses mobile phone to inform each of the herders of the community on a daily basis. In all three sites, herders also used the traditional way of "horse to horse" messaging ─depending on daily activities and conditions. The focal weather herder also measures and records local weather variables in a community weather log book.

In order to assess the quality of the data and the model used by RIMES, the team designed two parallel data verification practices. At the community level, herders agreed to carry out daily weather recordings using the same weather variables based on simple weather recording tools. To realize this, the team provided the basic equipment and training in its use, including a time-based thermometer, precipitation measurement device produced in Russia and Thailand, a barometer, an atmospheric pressure and temperature measure device, and an automatic multipurpose meteorological device *Krestel 4500* (Ykhanbai and team, November 2011). NAMEM staff compared RIMES data to the data generated by NAMEM for its national network of *sum* level weather stations over a period of one year. After one year of trials, according to NAMEM Ulaanbaatar staff interviewed, the RIMES data are accurate to a certain degree, in the summer more so than in winter. Herders commented that they find the RIMES data good, although they did observe certain variance. Herders did not seem so concerned about the absolute variance. Instead, it appears that they deemed the relative variance acceptable.

Mobile phone density in Mongolia has surpassed the one hundred percent. In Ulaanbaatar, many people own more than one mobile phone loading each one with a different sim-card according to particular rates offered by the major communication companies (G-mobile, Unicom, Unitel). In the rural areas, nowadays, many herders also have a mobile phone. However, connectivity remains a problem, in particular in the more remote mountainous areas. From any particular sum centre in the country, transmission capacity varies from 30-80km; in the mountainous areas (which cover most of the country), the range is often lower. Mongolia's extremely cold winters cause additional problems in terms of transmission. Power failures are not uncommon during winter time. In the communities, herders make increasingly use of solar power to generate electricity. For this, they use car batteries. It allows the (re)charging of fixed and mobile phones. Sometimes, however, cloudy weather periods prevent the generation of electricity. During times of moving, power generation is also difficult. Combined with the annual mobility of herders, these various factors make connectivity a "headache."

In some pasture areas and during some of the seasons, the mobile phone network is less effective, delaying the transfer of forecasts to the herders from one to several hours and sometimes, several days. In some cases it was difficult to transfer forecasts to all herder households within one region for the same reason. In particular in the high mountain summer pasture areas of Karatau and in some sites of the winter, autumn and summer steppe pastures in Aduunchuluun, the mobile phone networks experience difficulties. In the far away pastures of all sites, it is impossible to receive forecasts. This leads to interruptions in herders' planning; and to questioning of the the effectiveness of the systems overall.

The use of the weather forecast data in every day herders' livelihoods

The pilot efforts only established a novel and unique system to deliver localized weather forecasts, but also led to the building of a new two-ways relationship between NAMEM and herders, thus contributing to a more integrated and dynamic national weather system. The JASIL team played the very important role of connector and facilitator in this regard. Herders, on the one hand, expressed appreciation for the new weather knowledge acquired which they integrated without much trouble in their existing weather observation practices based on a large number of traditional indicators ─ranging from animal behaviour to the colours of "the mountains" (forest and pasture vegetation), to the ways in which rodents build their winter homes. NAMEM staff, on the other hand, realized the importance of accurate localized weather forecasts for herders across Mongolia, acknowledging the limit usefulness of *aimak* and *sum* data and the serious shortcomings in the existing transmission system. They also developed respect for the herders' capacities to become qualified, scientific, local weather readers! Since the start of the pilot project, herders have kept detailed weather records using the simple equipment provided to them. Over time, these observations allow the NAMEM staff to assess the validity of the new model being tested and make adjustments if necessary. This is establishing the base for a truly dynamic localized weather forecasting system. In the words of the Ikhbulag community leader, Altanshagai: "We are receiving the weather data every day and also recording data ourselves. We have become better in observing weather changes."

In all three sites, herders are making good use of the weather forecasts both at household and group levels. The most striking feature is that they have been able to improve their decision-making for key livelihood activities throughout the year and seasons. The fact that they had accumulated several years of experience of working together for co-management, certainly worked in favor at both levels of decision-making.

But not only is the weather the news of the day. Herders have increased the use of the communication system to exchange information more frequently with others, for example, to more efficiently organize the going to school of the children, the traveling to the *sum centre* and other places, and to obtain information about the prices of goods in the *sum* centre and even so far as the capital. For example, they were able to remain informed about the price changes of horse-milk, a product with a very high demand in certain months of the year. Selling horse-milk is for many herder families a key source of monetary income.

Toward a national system

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Herders in the pilot sites reported a significant reduction of animal losses and many a zero loss in the past winter and spring months. This could be partly explained by the relatively milder weather conditions as compared to the 2009-2010 winter, as well as a general improved level of preparedness which has been observed in many regions of the country (Vernooy and Erdenechuluun 2011). But herders in all three sites also attribute the much improved survival rates to the use of the localized weather forecasts (Ykhanbai and team July 2012). Herders in the pilot sites have followed the example of herders elsewhere in the country by preparing Climate Risk Management Plans using NAMEM's seasonal forecasts plus the localized weather forecasts.

The results have laid the foundation of a national system for Mongolia which can greatly improve the livelihoods of herders through more precise ex ante decision-making and planning, but also generate huge savings in terms of avoiding or reducing ex post disaster time, efforts, and expenses. From a technological perspective, the new delivery systems do not require much maintenance, other than care and regular control of the functioning of the ICTs and the weather measurement equipment. Of course, keeping the systems up and running also requires the timely payment of internet and telephone bills by all actors involved. Organizationally, herders seem very capable to continue the new systems. In fact, they have already begun, on their own, to expand the weather forecasting system to neighboring herders. They also have, as an unintended consequence, intensified the use of mobile and fixed phones, which must be good news for the telecommunication companies that are providing the services.

According to NAMEM staff, in the near future NAMEM will be able to generate as many localized weather forecasts as desired; and, according to the same interviewees, more accurate than the ones provided by RIMES currently. This is thanks to a new, so-called super-computer (i.e., faster and having more data processing capacity) recently purchased. In line with NAMEM's mandate, one could deduct that the costs of setting up and maintaining a national-level localized weather forecast system, at least from the data generation point of view, is expected to be borne by the Mongolian state.

The organization of herders in co-management groups takes time and effort, but once operational, these groups can serve as efficient and effective two ways transmission channels. Setting up new co-management groups may not necessarily be a pre-requisite for the scaling out and up of the new weather forecasting system, but from a Mongolian nomadic pastoral livelihood's perspective, co-management is considered a very important development strategy (Ykhanbai 2010, Vernooy 2011). The pilot experience suggests that an effective localized weather forecast system based on ICTs facilitates and strengthens interaction and cooperation among herders. This leads to the hypothesis that the scaling out of co-management could be made easier through the adoption of effective localized weather forecast systems based on ICTs. In order to facilitate the scaling out of the pilot experiences, the JASIL team has developed a manual for "community herder use of localized weather forecasts" (proposed title), in Mongolian, based on the three examples and lessons learned. According to Mongolian ICT specialists, it is foreseen that within 5-10 years from now many herders will be able to purchase improved mobile-phones which will have the capacity to connect to the internet. Considering this future scenario, the core of the service delivery system could become internet based. Then there is no more need to climb to the highest mountain top for making a phone call to the sum governor in times of disaster or any other moment.

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