Food and Agriculture Organization
of the United Nations

Preparing for sand and dust storm contingency planning with herding communities

A case study on **Mongolia**

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Abbreviations

DRR	disaster risk reduction
GPS	Global Positioning System
LG	local government
MET	Ministry of Environment and Tourism
MOFALI	Ministry of Food, Agriculture and Light Industry
NAMEM	National Agency for Meteorology and Environmental Monitoring
NDVI	normalized difference vegetation index
NEMA	National Emergency Management Agency
$PM_{2.5}$	particulate matter with diametre less than 2.5 µm
PM_{10}	particulate matter with diametre less than 10 µm
SDS	sand and dust storm(s)
SEC	State Emergency Commission

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Executive summary

A sand and dust storm (SDS) contingency planning process was implemented for Mongolia as a case study in the context of an FAO-led interregional project. The project also supported SDS contingency planning for agriculture in Iraq and the Islamic Republic of Iran. The Mongolian country component of the project focused on livestock herding the cropping sector in Mongolia is relatively small (cropland occupies only 0.6 percent of Mongolia's territory), and most crop fields in Mongolia are located in the north, which is less affected by SDS. Two rural *soums*[1] (Saintsagaan *soum* of Dundgobi province and Zamyn-Uud *soum* of Dornogobi province) were selected for study.

The contingency planning process was designed in three steps: (i) conceptualizing SDS risks from a livestock-herding perspective and (ii) conducting a systematic risk and vulnerability assessment in the study areas; this informed: (iii) a local level stakeholder consultation process to design location-specific SDS contingency plans. Based on location-specific prioritization, the contingency plans present measures that could help reduce herders' SDS exposure and risk in the future.

Sand and dust storm risk was determined probabilistically as a function of hazard and vulnerability, whereas vulnerability was conceptualized as a function of exposure/sensitivity and existing coping capacity. Weights were established for each component – hazard, exposure/sensitivity and coping capacity – to express their relative importance in the total assessment.

This report presents the outcomes and findings from the Mongolian case study. Chapter 1 aims to enhance our understanding of SDS in the context of agriculture in Mongolia. It includes information from a desktop review on key concepts related to SDS and its sources, approaches to estimating SDS risks, SDS scope and impacts, especially on livestock herding, and recent attempts to estimate SDS risks in Mongolia.

Chapter 2 provides a review and summary of existing policies and legal frameworks for dealing with SDS and describes the associated institutional structures in Mongolia. Based on the generic approach suggested by the FAO project, a methodology was proposed for developing SDS risk assessment models for herding communities, which was tested with stakeholders at various institutional levels. This process is presented in Chapter 3. Chapter 4 presents a sample SDS risk management plan that was developed in consultation with the stakeholders in the two *soums*. The development of the plan was based on a detailed baseline study in the two *soums, which* described the current situation and challenges/gaps at local government and herder household levels. The plan was developed to be easily replicated in other *soums*. Chapter 5 presents conclusions and suggested next steps.

[1] *Soum* is a rural district in Mongolia.

Chapter 1. Understanding sand and dust storms and their drivers in Mongolia

1.1 What are sand and dust storms?

Sand and dust storms (SDS) are a meteorological phenomenon that mostly originate in desert and semi-desert regions. It has been estimated that more than 2 billion tonnes of sand and dust move great distances through the Earth's atmosphere in these storms each year (Perkins, 2001), with adverse impacts on human health, the environment and economies.

Sand and dust storms occur when strong, turbulent winds combine with exposed loose soil on dry surfaces – conditions that are common in arid and semi-arid regions. Most dust emissions derive from natural sources, such as hyper-arid regions, topographic depressions in arid areas and dry ancient lake beds with little vegetative cover. Due to the wind-erodible nature of their surface material, exacerbated by dry conditions and limited vegetation, inland drainage basins in arid areas dominate the range of typical dust sources (UNEP, WMO and UNCCD, 2016).

Sand and dust storm sources and affected regions are often transboundary in nature, requiring dialogue and cooperation among the affected countries to generate appropriate policy interventions. Dust generally originates from a small geographical area before spreading to cover vast regions. When SDS spread from their source, the larger sand particles tend to hover close to the ground surface and thus do not travel too far. However, fine dust particles may be lifted kilometres high into the atmosphere, where strong winds transport them over great distances, even across continents.

The duration of SDS events varies from a few hours to several days. Their intensity is commonly manifested in terms of the atmospheric concentration of particles and the resultant reduction in visibility.

1.2 Main global drivers of sand and dust storms

The drivers of SDS include land degradation, desertification and climate change, exacerbated by unsustainable land and water use, extreme wind events, aridity, and frequent and severe droughts of extended duration. Droughts, typically associated with vegetation decline and drier soil, often result in more hazardous SDS events. Regional climate variables, such as high air temperature, minimal precipitation and strong winds, help drive the formation of dust storms. Natural phenomena, such as topographic depressions in arid regions (mainly dry ancient lake beds with little vegetation cover), contribute 75 percent of current global dust emissions. Anthropogenic factors, such as land-use changes, agriculture, water diversion and deforestation contribute the remaining 25 percent (United Nations, 2018).

Precipitation and temperature have likely been instrumental in increasing SDS frequency since 2000. Wind speed (especially of 10–20 m/s) is the main factor controlling the monthly variability of SDS, whereas precipitation (a major driver of vegetation cover) is a primary cofactor of inter-annual variability, although strong wind is still the main controlling factor (see Table 1.1).

Table 1.1 | Physical factors influencing wind erosion

CLIMATE	SOIL OR SEDIMENT	VEGETATION	LANDFORM
Wind speed (+)	Soil or sediment type	Type	Surface roughness (+/-)
Wind direction	Particle composition	Coverage (-)	Slope (-)
Turbulence (+)	Soil or sediment structure	Density	Ridge
Precipitation (-)	Organic matter (-)	Distribution (+/-)	
Evaporation (+)	Carbonates (-)		
Air temperature (+/-)	Bulk density		
Air pressure (+)	Degree of aggregation (-)		
Freeze-thaw action (+/-)	Surface moisture (-)		

Note: (+) indicates that the factor reinforces wind erosion; (-) indicates that the factor has a protective effect, reducing wind erosion; (+/-) indicates the effect can be positive or negative, depending on the process involved.

Source: **Babel, M.S.** 2018. Climate change and SDS in South, South West, and Central Asia. Presentation to High-level Expert Consultation on Regional Cooperation for Combating Sand and Dust Storms in Asia and the Pacific, 30–31 January. Tehran.

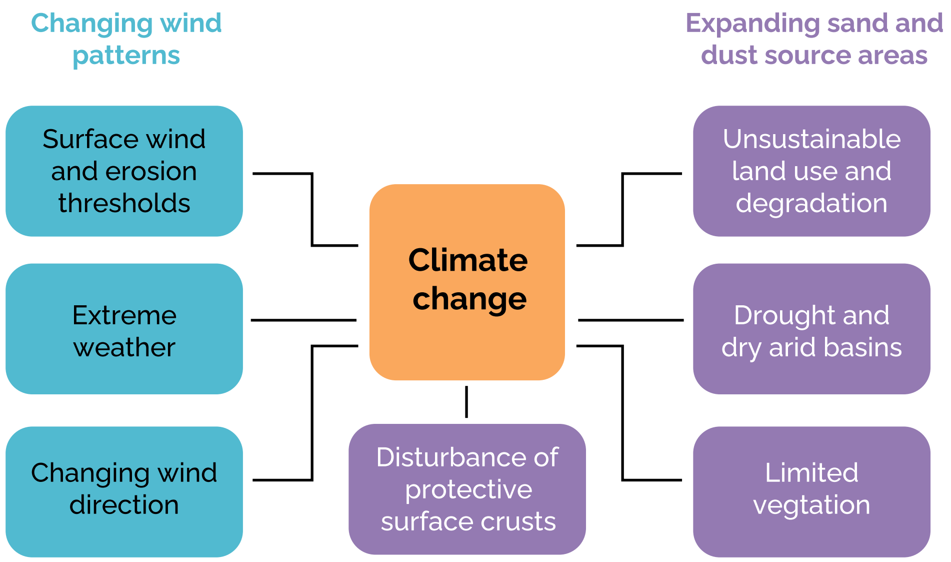
Global warming is an additional driver that leads to an increase in dry areas and has already contributed to an upward trend in drought-affected areas since the 1980s. In the first decade of this century alone, drought areas increased by about 8 percent. A study by Dai (2013) suggested that over the next 30–90 years, there will be widespread droughts due to either decreased precipitation or increased evaporation. This will likely lead to greater water stress across the Asia-Pacific region in the future (Dai, 2013).

According to Babel (2018), there are two primary climate change-related drivers of SDS: (i) changing wind patterns and (ii) expanding sand and dust source areas (see Figure 1.1).

Figure 1.1 shows that wind patterns fall into three categories: (i) fraction of surface winds exceeding the erosion threshold as defined by local surface properties; (ii) greater occurrence of extreme weather events; and (iii) changing wind direction. An expansion in sand and dust source areas is distinguished by four categories: (i) increased frequency of drought and dry arid basins; (ii) limited vegetation; (iii) unsustainable land use and degradation; and (iv) disturbance of protective surface crusts.

Droughts, which can result from irregularities in annual or season precipitation or from the overuse of water resources, can negatively affect soil fertility and lead to land degradation. Ecosystem degradation can lead to deforestation and desertification. Desertification, in combination with high-speed wind, leads to SDS.

Figure 1.1 | Drivers of SDS and their links to climate change



Source: **Babel, M.S.** 2018. Climate change and SDS in South, South West, and Central Asia. Presentation to High-level Expert Consultation on Regional Cooperation for Combating Sand and Dust Storms in Asia and the Pacific, 30–31 January. Tehran.

Natural processes can combine with socioeconomic conditions to speed the occurrence of sand and dust storms. For example, increasing populations place more pressure on land use, which can result in unsustainable land management and, ultimately, land degradation. In addition to encouraging SDS, land degradation reduces productivity and increases poverty.

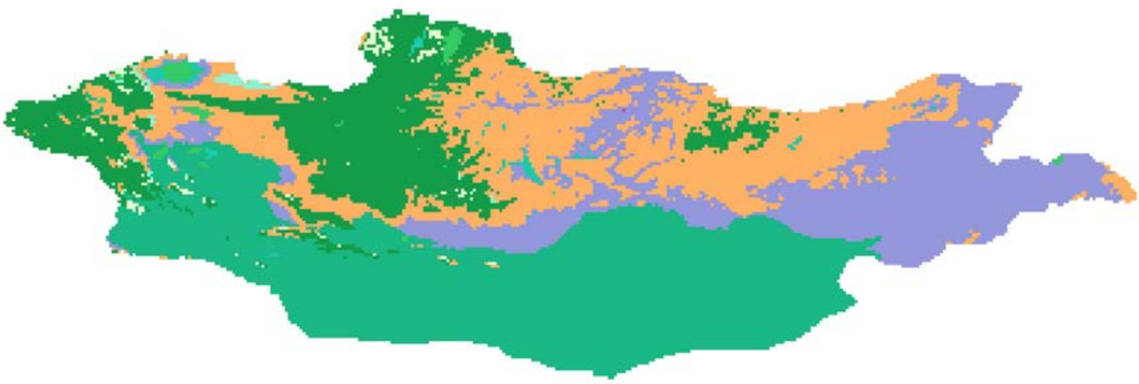
1.3 Sources and drivers of sand and dust storms in Mongolia

Mongolia is divided into three main zones: mountains, steppe and the Gobi Desert. The main characteristics of these zones include variations in average monthly temperatures in winter and summer, which range from −20 to −30 and 15 to 20 in the mountains, −20 to −25 and 15 to 20 in the steppe zone and −15 to −20 and 20 to 25 in winter and summer, respectively. Because of the range of highlands, vast steppes and desert, rainfall and temperatures vary greatly, not only seasonally but also daily. While the annual rainfall differs from 50- 150 mm, 150-200 mm and 250-350 mm in Gobi, steppe and mountainous zones (Purvev, 1990). Figure 1.2 shows a more detailed zoning of Mongolia with five agroecological regions.

Mongolia has relatively low precipitation. The precipitation generally decreases from the north to the south and from the east to the west, however, land contours play significant role in its distribution. Overall, the soil rate of evaporation or the evaporability (potential evapotranspiration) far exceeds the amount of precipitation. The amount of evaporability is less than 500 mm in high-mountain, 550–700 mm in forest steppe, 650–750 mm in steppe and 800–1000 mm in desert steppe and steppe regions (Ministry of Environment and Green Development, 2014).

According to the National Program for Community Participatory Disaster Risk Reduction, the average annual temperature increased by 2.07 °C between 1940 and 2013, which is a warming effect of three times the world average. Weather changes since 1961 include an increase in the number of hot days by 16–25 days; decreased annual precipitation by 9.4 percent; increased occurrences of short heavy rains with a decrease in mild rains; permafrost decline; drying out of numerous rivers, streams, lakes and springs; a two to threefold decline in pastureland vegetation diversity; a 20–30 percent decline in grass yield; and moderate to severe degradation affecting 78.2 percent of pastures (Government of Mongolia, 2015a). These trends have contributed to the increase of SDS events in terms of frequency and intensity. According to Middleton *et al.* (2011), there is empirical evidence of the links between desertification by overgrazing, drought and dust storms from the Gobi Desert of Mongolia. Although these factors are frequently connected, drought was found to be an important driver of vegetation cover change in and around the Gobi Desert.

Figure 1.2 | Map of Agroecological regions in Mongolia



Source: **FAO & International Institute for Applied Systems Analysis.** 2021. Global Agro-Ecological Zoning version 4 (GAEZ v4). In: FAO. Rome. www.fao.org/gaez/entps://gaez-data-portal-hqfao.hub.arcgis.com Modified to comply with UN. 2020. Map of the World. https://www.un.org/geospatial/file/3420

Using data from 32 weather stations, Natsagdorj and Jugder (2003) estimated the frequency of days with SDS across Mongolia. Locations with high frequency occurrences of SDS are key source areas for sand and dust movement. At the same time, they can be considered SDS-affected areas.

There is a pocket with very high SDS frequency in the western part of Mongolia, whereas the largest areas with high frequency are in the southern dry steppe and Gobi Desert regions, experiencing 31–60 and 61–90 days of SDS, respectively. The two *soums* selected for this study are located in large SDS-affected areas at the southern fringes of the Gobi Desert.

In the desert steppe and Gobi Desert, groundwater is used to supply water for domestic use and for animal watering. In the 1990s, there were more than 30 000 wells in the area, 15 000–17 000 of which were hand wells. In areas with no regular streams, herders gather around available spring or other water sources. If there is no snow in winter, they stay close to the same water source throughout the year. As a result, 1–3 km^2 pastures around the water points are overgrazed. In addition, cutting woody plants, particularly saxaul (*Haloxylon ammodendron Bge*) for fuel has loosened the soil and sand in the Gobi Desert.

Soil erosion caused by vehicles began in the early 1960s. The lack of paved roads led to the creation of many country earth roads, which removed vegetation cover and destroyed soil. Between 0.8–1.0 million ha has been destroyed by earth roads. Many herders have a car. For example, one herding family out of five has one or two cars.

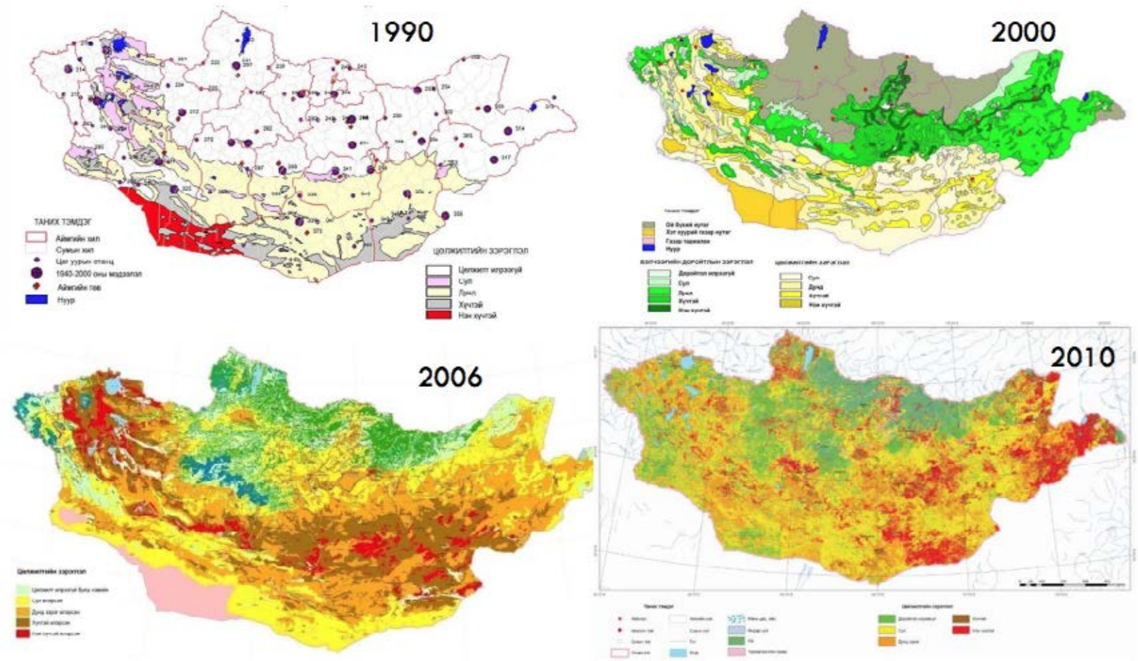
Very large areas of land have been disturbed due to different mining industries. Over 120 mining companies for building materials and 15 coal mining companies have destroyed 5212 ha of land because of surface soil removal. Land with at least 2 million tonnes of forage was lost as a result of 120 gold mining activities that explored 40.5 million ha area in the Ork hon-Selenge River basins (Natsagdorj, 2009).

The desertification atlas of Mongolia estimated and mapped levels of desertification and prevailing factors in land degradation for 2000 and 2010 (Ministry of Environment and Green Development, 2014). At that stage, natural (climate change) and anthropogenic (e.g. pasture pressure) factors had already been identified as drivers of desertification processes. Natural factors contributed 56 percent, and anthropogenic factors contributed 44 percent in areas that suffered from heavy or very heavy desertification (Ministry of Environment and Green Development, 2014). Another study put the contributions of these two factors at around 50 percent each (Natsagdorj, 2009). According to a 2014 assessment carried out by the National Agency for Meteorology and Environmental Monitoring (NAMEM) using 1450 monitoring points, 65 percent of pastureland in Mongolia had been degraded to a certain degree, with 7 percent desertified beyond recovery. Partly due to land degradation, over 40 million ha of the Mongolian steppe has been occupied by Brandt's vole (Microtus brandtii). Herders and local officials claim that these rodents are major destroyers of pasture forages. As a result, pasture productivity has been decreased up to 90 percent and vegetation species have been reduced by six times.

The latest update of the desertification map was published by the Ministry of Environment and Tourism Development in 2020 (see Figure 1.3). The map uses a wide range of indicators, including a normalized difference vegetation index (NDVI), vegetation conditions index, enhanced vegetation index, drought index, hot days, dusty days, particulate matter with diametre less than

2.5 µm ($PM_{2.5}$), organic carbon, livestock stocking density, pasture grass yield, population density, soil water and wind erosion.

Figure 1.3 | A history of desertification in Mongolia, 1990-2010



Source: **Van Cotthem, W.** 2019. Desertification and land degradation in Mongolia.
https://desertification.wordpress.com/2019/11/29/desertification-and-land-degradation-in-mongolia/

Shifting the policy focus from quantity to quality and productivity improvements, the 2012 Mongol Livestock Programme set the objective of developing a livestock sector that would be adaptable to changing climatic and social conditions in an environment that would be conducive to making the sector economically viable and market-competitive. The goals were to provide a safe and healthy food supply to the population, to deliver quality raw materials to processing industries and to increase exports. The programme also aimed to decrease the number of livestock from 43.3 million to 35.3 million by 2015. However, despite the well-known detrimental environmental impacts of grazing, herders in Mongolia have continued to manage livestock and pastures without adequate regulations, policies or incentives for sustainable livestock, pasture and water management. This has impaired the development of climate-resilient and profitable livestock production and marketing systems. Herd size maximization is still the dominant economic behaviour of herders aiming to generate livestock incomes. In 2019, Mongolia had 70.9 million livestock, achieving a historic record that exceeds the optimum pasture carrying capacity by 2.3 times. As a result, the pastureland has been severely overgrazed and degraded.

Although large herds give herders additional status and livelihood diversity, they also contribute to overgrazing, desertification, excessive resource use and inadequate animal feed, particularly during winter. Many of these factors contribute to enhancing SDS impact risk. The latest livestock-related policy document, *Action plan for the Mongolian Agenda for Sustainable Livestock*, approved by the Minister of Food, Agriculture and Light Industry in June 2018, set targets to restore, rehabilitate and utilize pastureland and water resources sustainably and responsibly, to adapt to climate change and to reduce the number of livestock by 5 million sheep units from 2017 to 2020. At the time, the pasture carrying capacity was exceeded by 25 million sheep units.

Sand and dust storms originating in Mongolia constitute a phenomenal environmental concern for the East and Northeast Asia subregions. Windborne dust particles are carried eastward, affecting not only China but also the Korean Peninsula and Japan where the dust creates a serious air pollution problem (Jung, 2016).

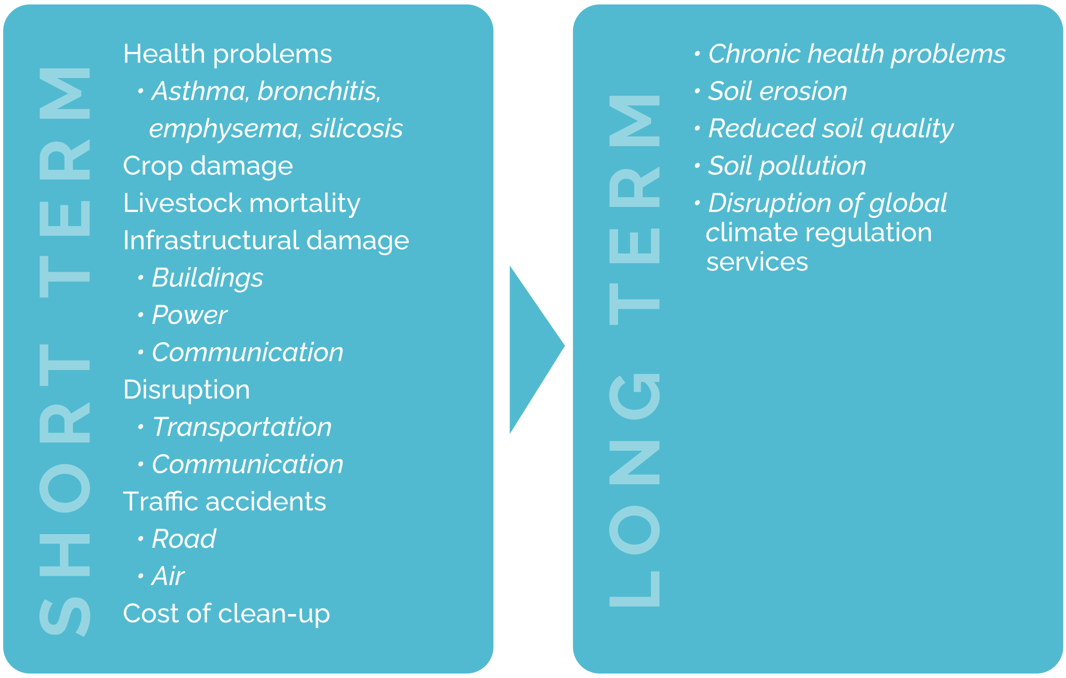
Mongolian researchers have conducted several studies of specific SDS events in cooperation with international partners. For example, Tsedendamba *et al.* (2019) studied the SDS event that took place in Mongolia from 28 March to 2 April 2012. A severe dust event originated over southern Mongolia and northern China on 28 March 2012, and the resulting widespread dust moved from the source area southeastwards towards Japan over several days. Windblown dust reached Japan from the originating area after two days. The study used data on particulate matter with diametre less than 10 µm (PM10) near the surface and light detection and ranging measurements from the ground up to 18 km. Light detection and ranging measurements of the vertical distribution of the dust were 1–2 km thick in the lower layer of the atmosphere, and increased with the growing distance from the source area (Tsedendamba *et al.*, 2019).

The Asian dust source regions are spreading eastward and northward from the conventional source due to degradation of the relatively moist zone (grasslands) in years that have experienced frequent Asian dust events (Igarashi, Fujiwara and Jugder, 2011). A 2015 review of the state of air pollution in East Asia (which includes Mongolia) recognized the region as a high dust emission zone (> 500 tonnes/km^2 annually). The annual mean dust and sand occurrence frequencies in the Gobi Desert are 19.8/site and 31.7/site, respectively. The annual total deposition amount in 2010 was 371.8 million tonnes (UNECE, 2018).

1.4 Impacts of sand and dust storms on agriculture in Mongolia

Sand and dust storms have wide-ranging economic impacts, both immediate and in the longer term. Short-term costs include crop damage, livestock mortality, infrastructural damage (to buildings, power and communications), interruption of transport and communication systems, air and road traffic accidents and the expense of clearing away sand and dust. Longer-term costs include chronic health problems, soil erosion, reduced soil quality, soil pollution and the disruption of global climate regulation services (see Figure 1.6), which in turn lead to rangeland degradation and livestock production losses in the medium- to long-term.

Figure 1.4 | Short- and long-term impacts of SDS



Source: **United Nations Environment Programme, World Meteorological Organization & United Nations Convention to Combat Desertification.** 2016. *Global assessment of sand and dust storms.* Nairobi, UNEP.

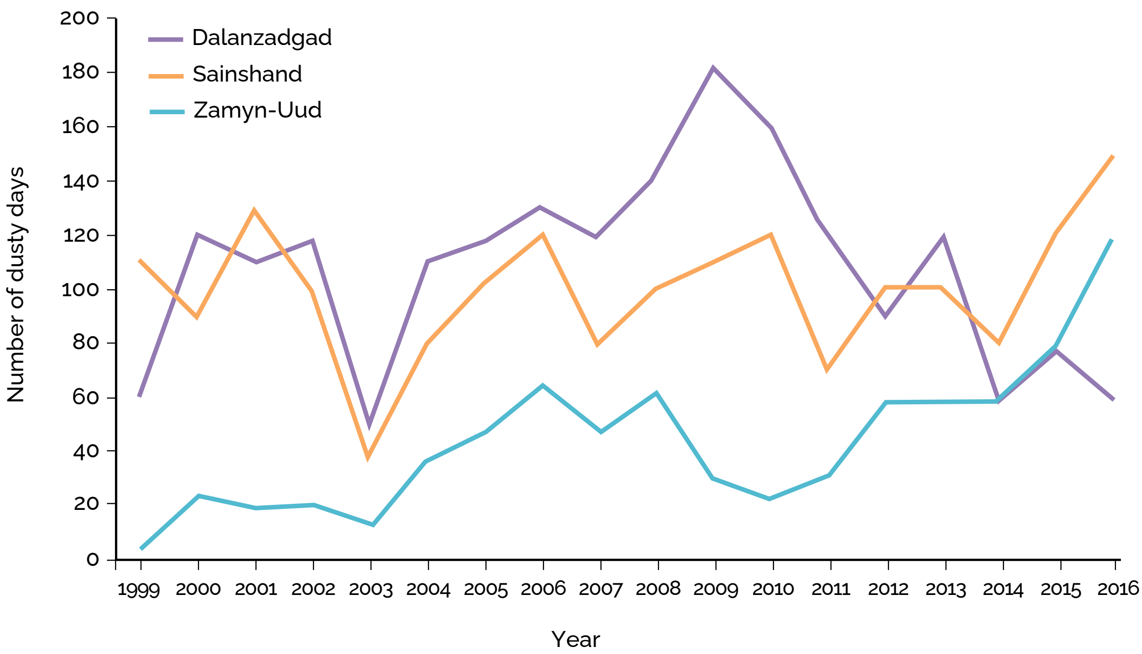
Soil degradation through reduced soil quality and erodibility are considered key categories for long-term SDS impact, while lands with degraded soils can quickly turn into SDS source areas. Judger *et al.* (2018) have estimated soil erodibility throughout Mongolia using a global soil database and an NDVI dataset. The integrated soil erodibility map revealed widespread areas of high erodibility from the desert and desert steppe regions in the south to the sandy areas in the west of the country. Low-erodibility areas extended from western to northern Mongolia, while medium-erodibility areas mostly covered the dry steppe regions and the desert steppe in the west.

Because of strong winds, dry soils and poor vegetation cover, SDS in Mongolia are most severe in the spring months from March to May. An analysis of storms in the Tengger Desert in China revealed that dust storms were more frequent between March and May and the frequency of SDS was found to be significantly higher from 2000 to 2007, compared to the 1980s (Guan *et al.*, 2015). Temperature and precipitation level also have an indirect effect on SDS activity due to their influence on vegetation growth. Storm data from China and Mongolia from 1980 to 2015 showed that annual dust emissions and annual wind speed had a positive correlation (R=0.49), annual dust emissions and annual precipitation had a negative correlation of R=−0.34 and annual dust emissions and annual temperature had a positive correlation of R=0.13 (United Nations, 2018). Some studies found that a threshold wind velocity for dust emission increases with snow cover fraction (Jugder, 2014).

The maximum daily mean PM_{10} (and $PM_{2.5}$) concentrations during dust storm periods were 821 (500) µg/m³ at Dalanzadgad, 308 (129) µg/m³ at Zamyn-Uud and 1328 µg/m³ at Erdene. Hourly maximum PM_{10} ($PM_{2.5}$) concentrations for all dust events at three stations during 2009 and 2010 ranged from 1333 (517) µg/m³ to 6626 (2899) µg/m³ (Jugder, 2014).

The number of days with SDS increased three to fourfold between 1961 and 2010 due to climate change and increased land degradation and desertification (Parliament of Mongolia, 2011). Figure 1.5 shows increasing trend in SDS from 1999–2016 in two out of three weather stations in the Gobi region, namely the Zamyn-Uud and Sainshand stations.

Figure 1.5 | Number of dusty days at Dalanzadgad, Sainshand and Zamyn-Uud, 1999–2016



Source: **Tsedendamba, P., Dulam, J., Baba, K., Hagiwara, K., Noda, J., Kawai, K., Sumiya, G., McCarthy, C., Kai, K. & Hoshino, B.** 2019. Northeast Asian dust transport: a case study of a dust storm event from 28 March to 2 April 2012. *Atmosphere*, 10(2): 69.

Sand and dust storms have many negative impacts on the agricultural sector, including reducing crop yields as seedlings are buried under sand deposits; lost of plant tissue and reduced photosynthetic activity as a result of sandblasting; delaying plant development; increasing end-of-season drought risk; increasing soil erosion and accelerating the process of land degradation and desertification; filling up irrigation canals with sediments; covering transportation routes; affecting water quality of rivers and streams; and affecting air quality. Livestock can be directly harmed if they are not sheltered from the storm, and stress from the physical environment can reduce their productivity and growth (Stefanski and Sivakumar, 2009).

The impact of SDS in Mongolia has not been adequately studied, with the exception of direct impact on livestock losses. According to NAMEM, an SDS stronger than 15 m/s prevents animal grazing, leading to productivity losses and animal fur matted with earth and dust. An SDS stronger than 5 m/s also erodes surface soils on crop fields and open steppe and desert areas with poor vegetation, leading to increased land degradation and desertification.

According to Danzannyam (1989), SDS occurrences that impact livestock grazing are common in Mongolia from February to April. They also occur in November. These occurrences can last from 1 to 20 days. Sand and dust storm days with cold temperatures below 0 °C are especially bad for livestock and completely prevent them from grazing for 80 percent of an event. However, this also depends on wind speed.

Ecosystem degradation erodes resilience and exposes communities and nations to increased risks and impacts from disasters. Combating desertification, protecting ecosystems and promoting restoration in pastures and wetlands offer sustainable and cost-effective approaches to SDS risk reduction.

Sand and dust storms damage the livelihoods and food security of thousands of herder households in Mongolia. Strong SDS can directly kill animals. For example, due to a severe SDS event in March 2021, 454 herder households in one *soum* (Saintsagaan in Dundgobi Province) lost 35 506 heads of livestock, including 16 485 sheep, 18 444 goats, 381 cattle, 167 horses and 29 camels (data collected by author).

In terms of the economic impact, desert dust events cost up to an estimated USD 5.6 billion annually in the Asia and Pacific region.

Chapter 2.
Institutional framework for addressing sand and dust storms in Mongolia

2.1 Key policies relevant to sand and dust storms

Law on Disaster Protection, 2017

The 2017 Law on Disaster Protection gives priority to snow and dust storms (which are included in the category of SDS), defining a "hazardous event" as a strong snow and dust storm, drought, *dzud*,[2] flood, lightning, earthquake, landslide, fire, breakout of highly contagious human and animal diseases, epidemic, spread of insects and rodents, etc.

The law regulates the processes and systems for organizing disaster protection activities in a timely and effective manner, as well as regulating actions related to the National Emergency Management Agency (NEMA) of Mongolia (see Section 4.2 for details).

Midterm Strategy to Implement the Sendai Framework for Disaster Risk Reduction in Mongolia until 2030 (approved by Government Resolution # 355, 2017)

The strategy aims to reduce disaster risk and prevent new risks by improving activities on:

- reducing disaster risk, exposure and vulnerability;

[2] *Dzud* is a very harsh winter condition during which the ground is frozen solid, sometimes under firm snow, making it impossible for animals to graze.

- disaster risk prevention and preparedness;
- disaster relief and recovery;
- capacity-building for disaster risk reduction (DRR).

Expected results include:

- approved national standards on DRR;
- a national system for disaster risk assessment;
- a national disaster information database.

Strategic management, organization and financing:

- The NEMA shall oversee action planning, organization and administration of the intersectoral integration of this mid-term strategy.

Monitoring and evaluation:

- The NEMA shall report to the cabinet every two years.

National Programme for Disaster Risk Reduction with Participation of Communities (approved by Government Resolution # 303, 2015)

The programme summarized the challenges related to disaster risks in the context of accelerating climate change. It concluded that:

- From 1940 to 2013, the average annual temperature increased by 2.07 °C, which was three times the global average.
- Mongolia faces around ten natural hazards annually, including drought, *dzud*, snow and dust storms, tornado, desertification, lightning, downpour, flood and outbreak of contagious diseases.
- For the past 20 years, Mongolia has experienced natural hazards of drought, *dzud*, lightning, downpour, snow and dust storms, hail, flash increased frequency and severity of floods, and the damage caused by such hazards to society and the economy has doubled.

In setting policy targets for DRR, the programme focused on improving the participation of citizens and communities in DRR, with no specific reference to SDS or snow and dust storms.

National Plan for Prevention and Rescue of Population, Animals and Properties from Disaster, Disaster Response and Early Warning (approved by Government Resolution # 416, 2015)

This plan is designed to protect densely populated and industrial areas against serious socio-economic losses resulting from damage to peoples' health and lives, infrastructure and the environment, and the mass mortality of animals. The plan includes measures that are specific to each of the main hazards. Table 2.1 shows the measures for strong snow and dust storms[3] (Government of Mongolia, 2015b).

Table 2.1 | Measures for strong snow and dust storms

NO	MEASURES	RESPONSIBLE LEAD ORGANIZATION	SUPPORTING ORGANIZATIONS
1	Provide early warning about an event.	NAMEM	NEMA
2	Identify and protect herders in potentially affected areas.	NEMA	Local government (LG)
3	Organize measures to prevent people in settlements from being lost and buildings and structures from freezing.	NEMA	LG
4	Close traffic to and from the affected areas.	Police	LG, NEMA
5	Appoint search teams.	NEMA	Ministry of Food, Agriculture and Light Industry (MOFALI), police, LG
6	Organize activities to find and rescue lost people and herders on pastures with livestock.	NEMA	MOFALI, police, LG
7	Provide herders, search teams and citizens with warm clothing, food and petrol.	Operational teams	Ministry of Mining, LG, Red Cross, donors, MOFALI
8	Clean roads and pastures of snow.	Ministry of Roads and Transportation (MRT)	Ministry of Mining, LG
9	Provide information on the disaster.	Government media, public relations teams	Ministry of Environment and Tourism (MET), MOFALI, LG
10	Support affected households and citizens with fodder, food, medicine, materials.	MOFALI	NEMA, Red Cross, donors, LG
11	Assess damages and organize recovery for people who lost housing, livestock and other property.	State Emergency Commission (SEC)	National Office on Disaster Protection
12	Clear bodies and remains of lost livestock.	MOFALI	NEMA, General Agency for Specialized Inspection, Red Cross, donors, LG

Source: **Government of Mongolia.** 2015b. *National plan for prevention and rescue of population, animals and properties from disaster, disaster response and early warning.* Ulaanbaatar.

[3] SDS may also be used to refer to snow and dust storms.

State Policy on Disaster Protection and National Programme on Capacity Building for Disaster Protection (approved by Parliament, Resolution #22, 2011)

This policy and programme are focused on disaster protection in general and have no specific targets and regulations regarding SDS.

National Action Programme on Climate Change, 2011

The programme concluded that:

- Since 1961, the annual potential evapotranspiration rate has increased by 118.1 mm and growing season precipitation has decreased by 33 mm due to climate change, leading to severe aridity and desertification.
- Periods of bare soil without snow or vegetation have been prolonged due to the snow cover melting up to one month earlier than usual.
- As a result, soil erosion caused by wind has increased and the number of dust storm days has increased three to fourfold since 1960.

The programme set targets to increase production efficiency and productivity and to support green growth and development by improving ecological balances, climate-smart socioeconomic development and reducing DRR vulnerabilities and greenhouse gas emissions.

Given the strong impacts of climate change on SDS in Mongolia, the programme highlighted the role of the Ministry of Environment and Tourism in addressing environmental problems that lead to increased SDS. The programme (Section 4.2.2.4) assigned the following tasks to the Ministry:

- develop government policies and strategies on climate change;
- enforce the legal requirements for the protection, conservation and appropriate use of natural resources;
- improve soil, water and forest resources management;
- strengthen environmental monitoring networks;
- conduct necessary research;
- disseminate scientific information about the environment to individuals and institutions;
- coordinate the actions of multiple ministries, agencies and organizations.

According to the programme (Section 4.2.4.7), MOFALI was assigned implement measures and projects to:

- mitigate greenhouse gas emissions from the food and agriculture sector;
- adapt to climate change in arable farming and animal husbandry.

Under the programme (Section 4.2.4.13), NEMA is responsible for early warning systems and natural disaster preparedness. It also supports community groups in disaster management and strengthens risk management activities.

It is worth noting that, because SDS in Mongolia occur mostly from March to May, which are months with subzero temperatures, SDS are not differentiated from snow storms. Instead, the term "snow and dust storm" is used prevalently. The low temperatures, especially at night, are a key factor leading to livestock mortality.

2.2 Organization and financing of disaster protection in Mongolia

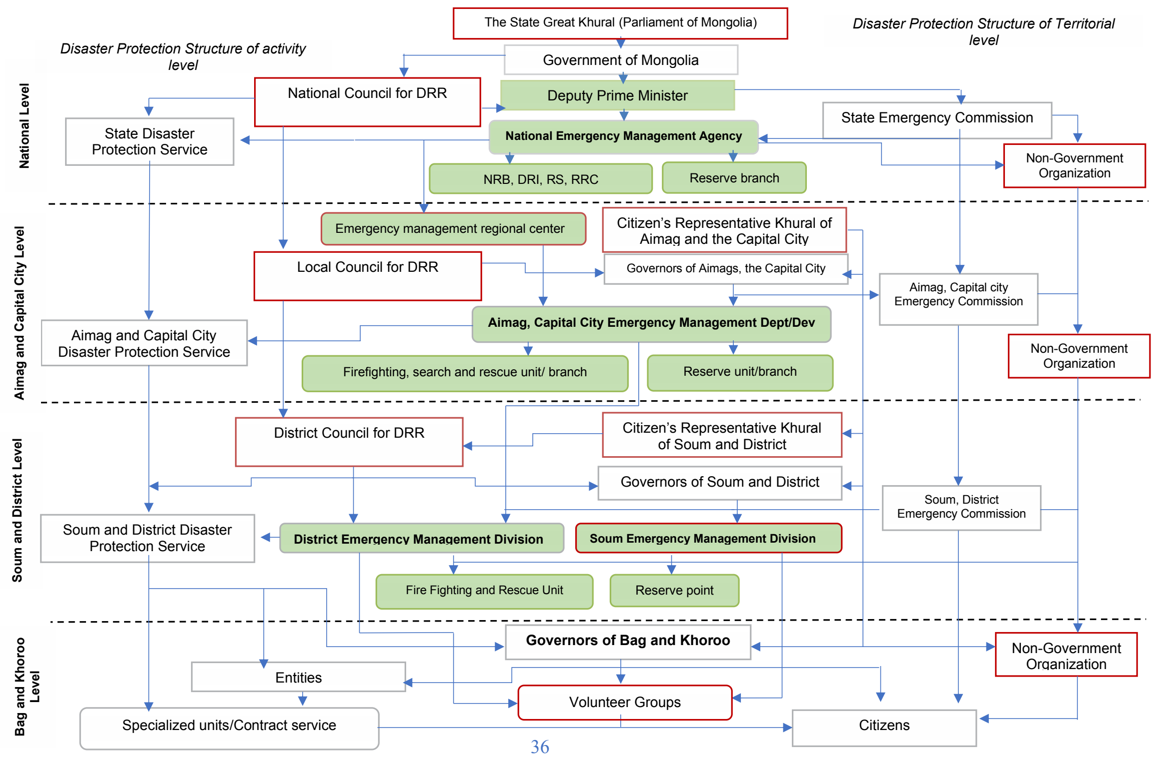
It is worth explaining the meaning of disaster protection in the Mongolian context. According to the Law on Disaster Protection (2017), "disaster protection activities" include the "implementation of disaster prevention, search, rescue, response, humanitarian assistance and emergency recovery measures" (Article 4.1.7). The organization of disaster protection is regulated by Article 22 of the Law on Disaster Protection as follows:

- Disaster protection activities are organized by administrative and territorial units, state and local administrative organizations and legal entities regardless of ownership, whether public, private or mixed.
- The NEMA shall coordinate the activities of state organizations, local governments and legal entities, and the participation of citizens in the planning, organization and implementation of disaster protection activities at the national and local levels.
- To promptly organize and coordinate intersectoral disaster protection activities, exchange information, and rationally allocate resources and resources, part-time disaster protection services are established for key areas such as food and agriculture, health, etc. at the national *aimag*[4] and *soum* levels.
- The government establishes a state emergency commission (SEC) and local governors establish *aimag* and *soum* emergency commissions to manage, coordinate and monitor disaster protection activities.
- *Aimags*, the capital city, *soums*, districts and legal entities have professional units to support disaster protection activities.
- *Soums* and *baghs*[5] may have voluntary community-based disaster protection units.

In addition, DRR councils are established at the national and local levels to make policy recommendations and to incorporate them into development policy and planning. Thus, disaster protection activities are organized by administrative units of *aimags* and *soums* under the supervision of NEMA.

4 *Aimag* is a first-level administrative subdivision or province.
5 *Bagh* is an administrative unit within a *soum*.

Figure 2.1 | Disaster Protection Institutional Framework of Mongolia



Source: **NEMA**. 2022. *Mongolia's National Midterm Review of the Sendai Framework for Disaster Risk Reduction Report.* Ulaanbaatar. https://sendaiframework-mtr.undrr.org/media/87207/download?startDownload=true

Disaster protection finances are regulated by the Law on Disaster Protection. Article 51 states that:

- *Aimags*, *soums* and government organizations are responsible for ensuring that disaster protection finance accounts for at least 1 percent of the country's annual budget.
- Legal bodies are responsible for making sure that enterprises, whether public or private, allocate at least 1.5 percent of total annual production and services costs to disaster protection measures.

2.3. Responsibilities of key agencies relevant to sand and dust storms

Agriculture risk management has been distributed among different ministries and agencies. The mandates of government ministries relevant to SDS risk management-related matters are described in Article 20.5 of the Law on the Government of Mongolia (first adopted in 1993 and last updated in 2021). According to Article 20.5, relevant individuals and institutions have the following responsibilities:

Deputy Prime Minister

- disaster protection;
- prompt action for operational recovery and rehabilitation.

Ministry of Environment and Tourism Development

- green development;
- combating desertification and afforestation;
- protection of fauna and flora;
- environmental monitoring, preventing potential weather and natural hazard-induced disasters and ensuring ecological safety.

Ministry of Food, Agriculture and Light Industry

- use of agricultural land and pastures;
- protection of pasture vegetation and cultivated crops;
- protection of livestock from sudden climate hazards.

In addition, specialized government agencies under ministries conduct activities that are relevant to SDS. Their mandates and duties are regulated by the relevant laws and the ministers.

National Emergency Management Agency

In accordance with the Law of Mongolia on Disaster Protection (2017), NEMA coordinates disaster protection activities nationwide. It has branches in 21 provinces and the capital city. The main duties of NEMA include:

- organizing, ensuring and monitoring the implementation of disaster protection legislation, state policy, decisions of the government and government members in charge of disaster protection;
- developing and approving Mongolia's disaster protection plan, organizing and monitoring its implementation;
- directing and monitoring the activities of local emergency management organizations;
- informing the population about disasters, catastrophes, accidents and dangerous situations through the media or directly, and providing instructions and recommendations;
- preparing necessary information and conducting research;
- organizing and monitoring the delivery, transportation and distribution of goods, materials, domestic and international humanitarian aid to the required places;
- coordinating the disaster protection activities of the disaster protection service, state and local administrative organizations, legal entities and specialized units; providing professional and methodological guidance and support;

- managing and replenishing the disaster reserves;
- developing rules, regulations, instructions and standards related to disaster protection activities;
- issuing and revoking licences and monitoring the activities of legal entities conducting disaster risk assessment;
- monitoring the implementation of measures taken by state and local administrative bodies on disaster protection;
- studying and promoting the implementation of disaster protection legislation and submitting proposals to the competent authority to improve the legislation;
- communicating with foreign governments, international and domestic organizations, developing cooperation and providing professional support on disaster protection issues;
- implementing activities to educate and prepare the population for disaster protection activities.

National Agency for Meteorology and Environmental Monitoring (NAMEM)

NAMEM has several divisions that are engaged in producing and disseminating climate-related information.

National Network and Climate Service Division

- Organize monitoring and evaluation of state and quality of water, climate and environment at national level and provide counselling on potential disaster risk hazards that could be triggered by hydrological and climate events.
- Develop hydrological, climate and environmental database and provide users with information services such as weather forecasts.

Information and Research institute of Meteorology, Hydrology and Environment

- collect, process and disseminate national, regional and local data for:
- natural disaster database;
- disaster information services;
- forest and steppe fire database.

Early warning division:

- produce and broadcast short- and long-term weather forecasts and warnings on hazardous and disastrous climate events on national radio;

- produce sectoral-scale short- and long-term weather forecasts and warnings on hazardous and disastrous climate events integrated with local weather services and broadcasting;
- supervise local early warning units based on technological and methodological guidelines.

Weather forecasting:

- every three hours;
- every six hours for Ulaanbaatar;
- every twelve hours, between 08.00 and 20.00;
- every one to five days, texted;
- weekly or for seven days;
- monthly;
- seasonally.

Monitoring SDS:

In 1936, the visual observation of dust storms began in Mongolia when the first meteorological stations were established at the National Agency for Meteorology and Environmental Monitoring. As the meteorological observation network expanded, so did dust storm observations. Since 2014, visual synoptic observation of dust storms has been conducted in 135 meteorological stations and 181 posts across the country. In 2006, a new network that includes dust storm, dust measurement, monitoring and early warning systems was established in the National Agency for Meteorology and Environmental Monitoring. In 2013, the number of dedicated dust-measuring stations reached 11, creating a dust monitoring network.

2.4 Externally-supported services relating to sand and dust storms

The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) assists with access to the Earth-observation satellite-based normalized difference vegetation index and the aerosol index, which are used to understand the geography and interconnectivity of SDS related slow-onset phenomena and to identify potential risk hotspots, as well as enabling real-time risk assessment and monitoring (United Nations, 2018). UNESCAP also provides a template for forecasting and warning systems that rely on measuring and monitoring the relevant indicators. Earth-observation satellites (e.g. SRTM, ASTER and CartoDEM) provide mapping and monitoring data for vegetation cover, snow cover and soil moisture and wetness, along with surface topography.

2.5 Key challenges to the implementation of policies relevant to sand and dust storms

Key challenges to the implementation of government policies for disaster protection include a lack of finances and technical expertise, and weak institutional settings, especially at local government levels. As a result, most government policy priorities are not translated into action.

As we learned from interviews with government officials in the two pilot *soums*, the *soum* governors have been unable to include adequate funding in their annual budgets and, when emergencies strike, must draw on their reserve budgets and rely on outside assistance.

Job descriptions of relevant civil servants reflect DRR functions in very short and general terms. Combined with the lack of financial resources, this makes relevant officials less motivated to deliver required outputs to carry out their DRR responsibilities.

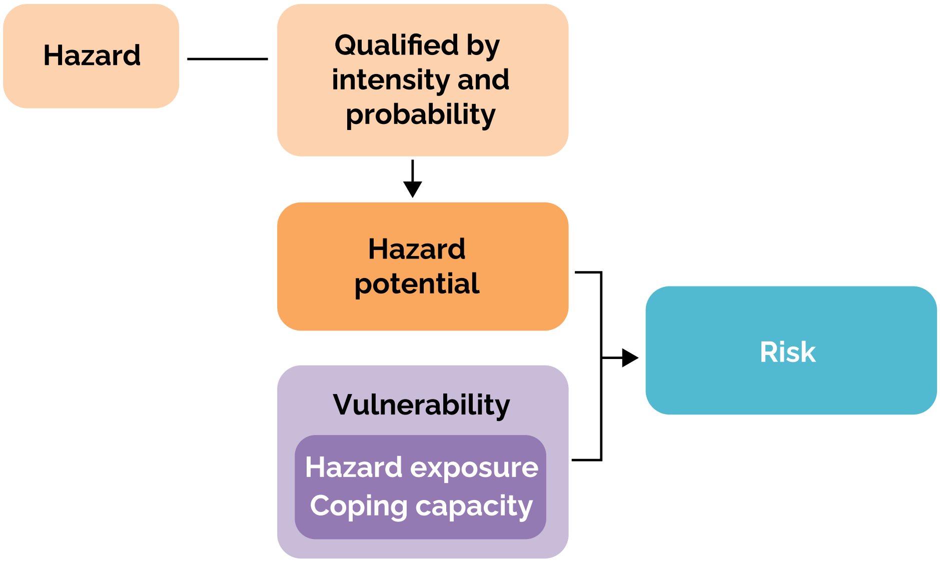
Chapter 3.
Proposed sand and dust storm risk assessment model for livestock herding in Mongolia

3.1 General approach to disaster risk assessment

The United Nations Office for Disaster Risk Reduction defines disaster risk as "the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity" (UNDRR, 2022a). This can be expressed as the following equation (see also Figure 3.1):

risk = hazard × vulnerability (as a function of exposure/sensitivity and coping capacity).

Figure 3.1 | Interrelations of disaster risk components



Source: **Greiving, S.** 2006. Integrated risk assessment of multi-hazards: a new methodology, natural and technological hazards and risks affecting the spatial development of European regions. *Geological Survey of Finland, Special Paper* 42, 75–82.Espoo, Finland, European Spatial Planning Observation Network. https://tupa.gtk.fi/julkaisu/specialpaper/sp_042.pdf

It is preferable to have weightings for each component – hazard, exposure, vulnerability, coping capacity – in order to express their importance in the total risk assessment.

Mongolia's agricultural community is dominated by extensive pastoral livestock management composed of individual herder households scattered over a huge territory with poor infrastructure. There are customary neighbourhood groups that mostly depend on the shared use of key pasture resources, like water points, mountain valleys and salt licks. These tend to have very loose boundaries and memberships. Livestock and pasture risk management is organized by *soums*. The average *soum* comprises around 330 000 ha of pastureland and 500 herder households. Each *soum* is divided into three to six *baghs*. A *soum* with good data availability and clear boundaries and a responsible government can ensure that a "community perspective" is included in the livestock risk assessment.

Disaster risk is not just the likelihood and severity of a hazard event but also concerns exposure to that hazard and the vulnerability of that exposure. A hazard is any source of potential damage, harm or adverse health effects on something or someone. Vulnerability concerns the conditions determined by physical, social, economic and environmental factors that determine the exposure and/or processes that increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

According to the definition of the United Nations Office for Disaster Risk Reduction, exposure is the "situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas" (UNDRR, 2022b).

The commonly acknowledged key steps in risk assessment are the following:

- Identify the hazards that might affect the system or environment being studied.
- Assess the intensity and frequency of the hazards that might occur. Inputs to this process include past hazards, modelling, experience, corporate memory, science, experimentation and testing.
- Estimate vulnerability to the hazard. This can be established by determining who or what is at risk and reviewing historical events and/or expert opinion to ascertain the ability of the system to mitigate loss after a hazardous event.

In practice, preventive DRR planning usually focuses on high- to medium-frequency/low- to middle-impact events that are likely to occur, and whose impacts can be either prevented, mitigated or prepared for, and thereby managed. An effective emergency response system is often the only way to cope with impacts of the most extreme, low-frequency/high-impact events.

3.2 Indicator development for sand and dust storm risk and vulnerability assessment in agriculture

A national expert panel was established to develop a country-specific set of indicators of SDS risk in line with the components of a common DRR function. The indicators were based on the criteria of: (i) relevance to SDS in agriculture; (ii) existing indicators or indices; (iii) data availability; and (iv) data accessibility A ranking and scoring system was developed by a *soum*-level expert panel, which weighted the indicators and components of risk and vulnerability to ensure the highest applicability to the *soum,* while considering data availabilities. The composition of the proposed indicators is in line with the approaches presented in Section 3.1.

The following are the proposed hazard indicators:

1. sand/snow and dust storm frequency;
2. wind intensity;
3. dust concentration level;
4. temperature (accounts for wind-chill effect on animals);
5. drought conditions.

The following are the proposed exposure/sensitivity indicators:

6. soil characteristics required for SDS susceptibility and severity;
7. vegetation characteristics required for SDS susceptibility and severity;
8. *dzud* conditions in previous months;

9. seasonal stocking density;

10. level of overgrazing.

Most of the required hazard data were available from NAMEM. Sand and dust storm severity and SDS frequency have been proposed as new indicators by the national consultant. Other required data were provided from annual statistics held by *soums* (see Table 3.1)

In terms of the stocking density – the number of animals in sheep units per 100 ha:

- Stocking density is highly variable. Areas close to settlements, roads and other infrastructure hubs are heavily inhabited by human and livestock populations posing a greater exposure to any risks. In contrast, remote areas are usually less dense, thus significantly decreasing the exposure.
- As the value of livestock varies greatly across species, an aggregate indicator is needed for comparability. Sheep units are proposed as an aggregate indicator.

Livestock numbers are available from annual animal census data gathered by the National Statistics Office in collaboration with local governments each December. Pastureland areas are also measured and recorded annually and the data are available from the Agency for Land Relations, Geodesy and Cartography.

The following are the proposed indicators for coping capacities:

11. animal shelter supply expressed as a percentage of ownership (i.e. X percent of all farmers have animal shelters);

12. communication capacity – mobile phone ownership;

13. local rescue and transport capacities number of available vehicles for animal transport;

14. supplementary fodder supply – amount of supplementary fodder needed per sheep unit.

The proposed model for SDS risk assessment, including variables, description, weights, measurement indicators, assessment timing, scores and weights, is shown in Table 3.1.

Table 3.1 | Model for SDS risk assessment in Mongolia

RISK ASSESSMENT COMPONENTS AND KEY VARIABLES		DESCRIPTION	INDICATORS	ASSESSMENT TIMING: WHEN, WHICH PERIOD	SCORES	WEIGHT (%)	COMPONENT WEIGHT (%)
Hazard	1. SDS frequency	Short-term conditions	Number of days with SDS from March–May	Daily, March–May, CY	1–5	5	40
	2. SDS severity	Triggers SDS and determines its severity	Product of wind speed (m/s) and duration (hours) of days with SDS from March–May	Daily, March–May, CY	1–5	15	
	3. Dust concentration level	Immediate conditions	PM_{10} level (data from local monitoring or the World Meteorological Organization's SDS Warning Advisory and Assessment System)	Daily, March–May, CY	1–5	5	
	4. Temperature (accounts for wind-chill effect on animals)	Immediate conditions	Daily temperature	Daily, March–May, CY	1–5	5	
	5. Drought conditions	Short-term conditions	Standardized precipitation evapotranspiration index (SPEI)	Monthly, March–May, CY	1–5	10	
Exposure	6. Soil characteristics critical for SDS susceptibility and severity	Mid-term trends	Integrated soil erodibility map	Once, for previous 3–5 years	1–5	6	23
	7. Vegetation characteristics critical for SDS susceptibility and severity	Mid-term trends	NDVI monitoring/ desertification map	Once, for previous 3–5 years	1–5	6	
	8. *Dzud* conditions in previous months	Short-term conditions	*Dzud* risk classes	Once, December, PY	1–5	3	
	9. Seasonal stocking density	Short-term conditions	Number of sheep units per 100 ha	Once, December, PY	1–5	8	
Vulnerability/ coping capacity	10. Level of overgrazing	Medium- to long-term conditions	Annual average animal numbers compared to optimum (%); percentage area of high desertification class/rate	Once, December, PY	1–5	15	37
	11. Animal shelter supply	Short-term conditions	Supply (%)	Once, December, PY	1–5	10	
	12. Communications capacity	Short-term conditions	Share of households with mobile phones (%) and georeferencing application	Once, December, PY	1–5	8	
	13. Supplementary fodder supply	Short-term conditions	Feed unit (kg) per sheep unit	Once, December, PY	1–5	4	

Source: Author's own elaboration

Notes: Mid-term trend refers to timing for 3–5 years; short-term conditions refer to timing of less than a year, usually 3–5 months; immediate conditions refer to timing of less than a day. For risk assessment in any particular year, the values for mid-term and short-term variables will not change, while values for immediate and trigger variables will change according to when the SDS events happen. The model can be used for SDS risk forecasting using data for immediate and trigger variables. CY = current year; PY = previous year.

A five-score system was used to estimate the score for each variable. The weighted average score is used to define the risk classes in Table 3.2.

Table 3.2 | Weighted average score and SDS risk class for the five-score system

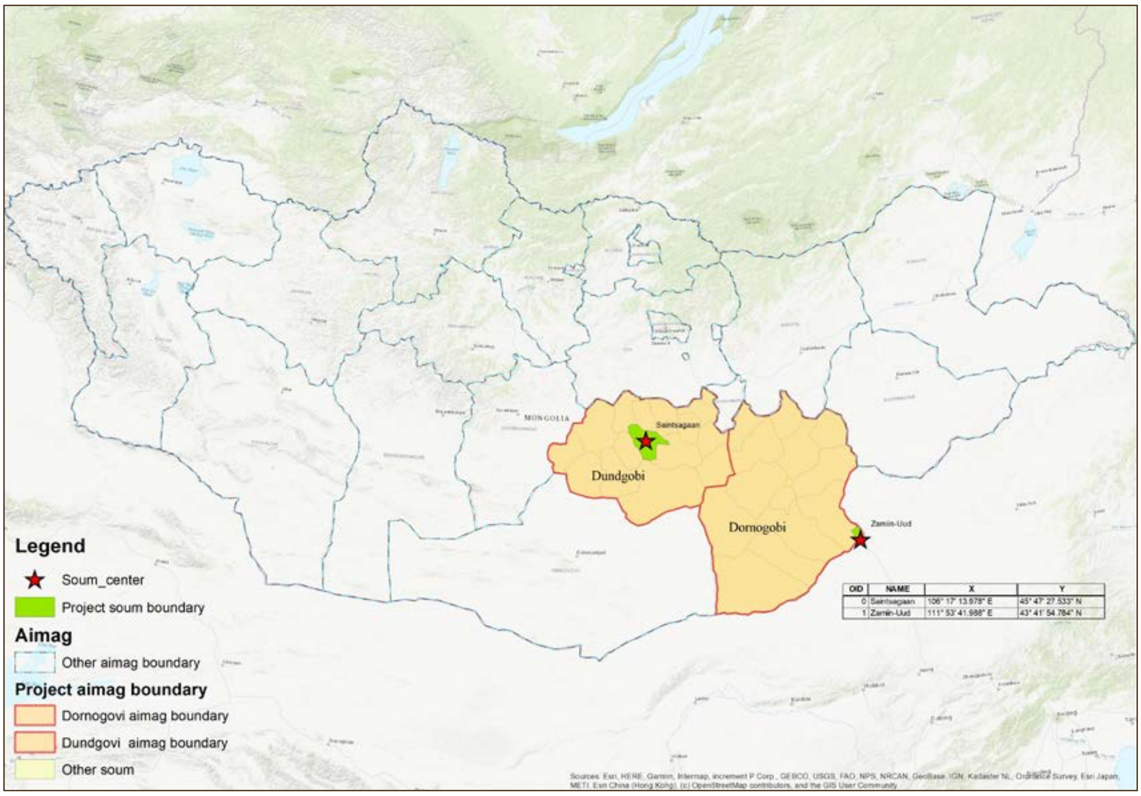
Weighted average score	SDS risk class
1.5 or lower	Very low risk
1.6–2.5	Low risk
2.6–3.5	Moderate risk
3.6–4.5	High risk
4.5 or higher	Extremely high risk

Source: Author's own elaboration

Chapter 4:
Applying the risk assessment model to sand and dust storm planning

The proposed model was tested in the Saintsagaan *soum* of Dundgobi *aimag* and the Zamyn-Uud *soum* of Dornogobi *aimag*. Figure 4.1 shows the location of the two *soums*.

Figure 4.1 | Location of two pilot *soums* with coordinates



Source: Author's own elaboration. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

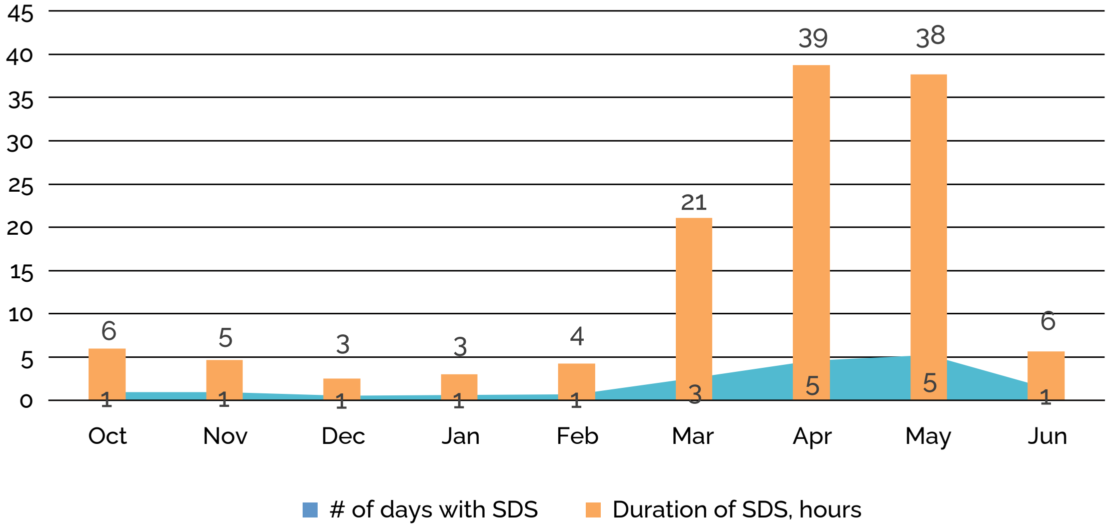
4.1 Preliminary results from risk and vulnerability assessment

This chapter presents the results of applying selected indicators to illustrate the SDS risk assessment methodology. The assessment covers the past 20 years to enable a comparison of SDS risk levels in the two *soums* and to serve as a basis for location-specific SDS contingency planning with local stakeholders. The results of the priority-based local planning process are presented in Section 4.2.2.

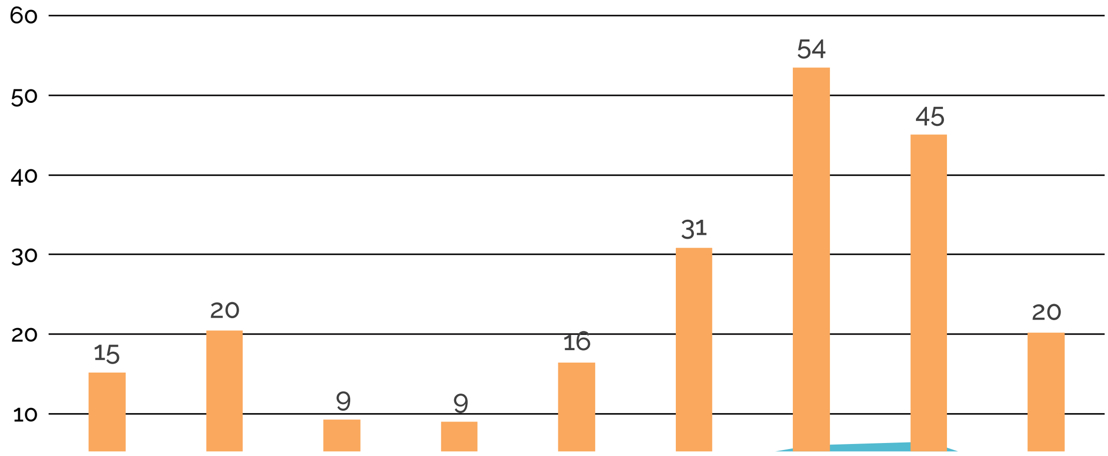
Figure 4.2 shows that SDS events were most common in March to May when the *soums* experienced more and longer days of SDS.

Figure 4.2 | SDS frequency (# of SDS days) and duration of SDS (in hours), monthly average for 2000–2020: (a) Saintsagaan *soum* and (b) Zamyn-Uud *soum*

A.



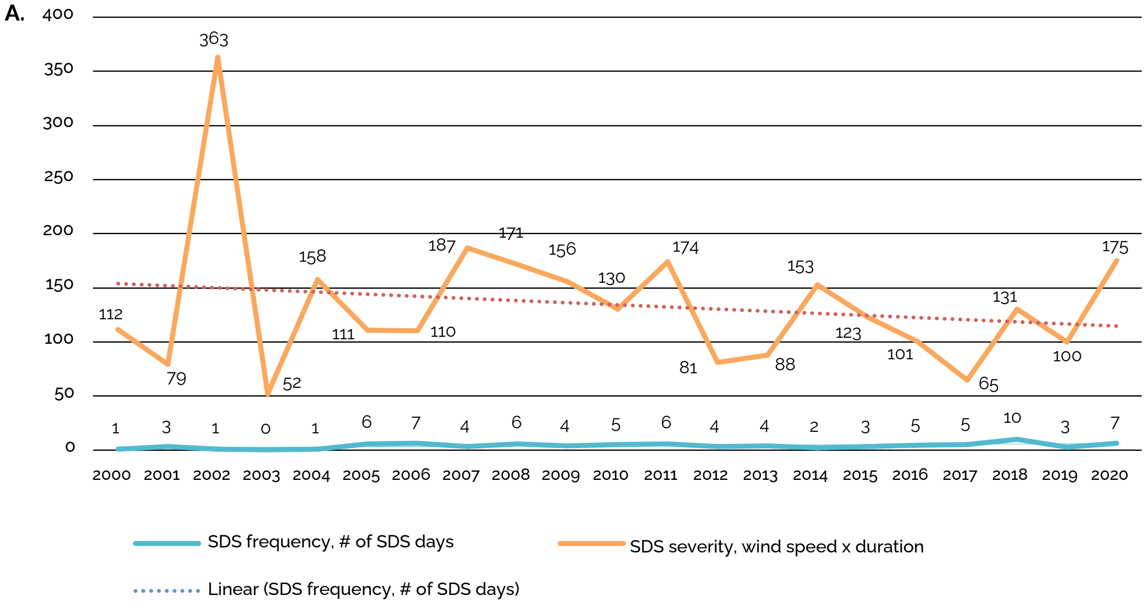
B.

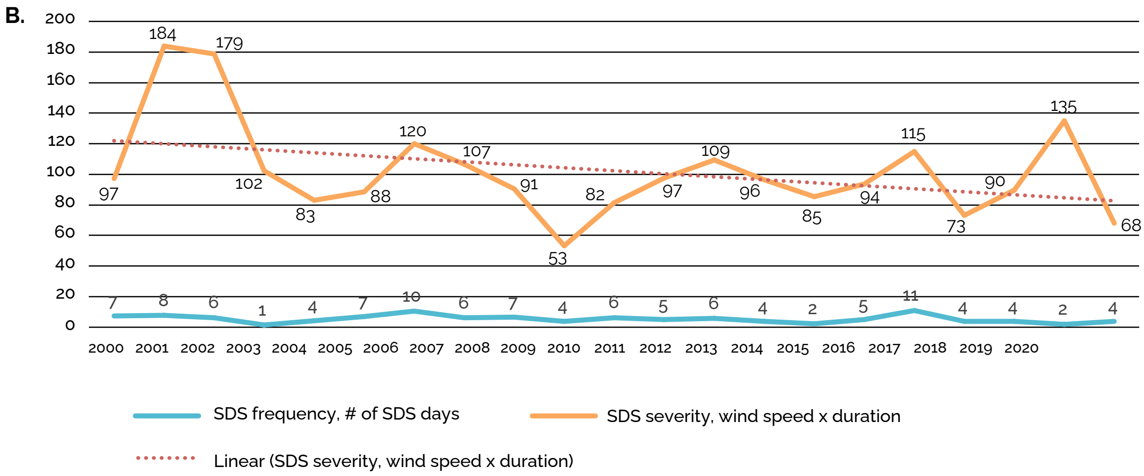


Source: Author's own elaboration

Sand and dust storm severity is estimated as a product of wind speed (m/s) and duration (hours) of days with SDS in March to May. Figure 4.3 shows that SDS severity had high year to year variability and exhibited a slightly decreasing trend over time from 2000 to 2020 in both *soums*.

Figure 4.3 | Sand and dust storm severity and frequency, March–May average: (a) Saintsagaan *soum* and (b) Zamyn-Uud *soum*

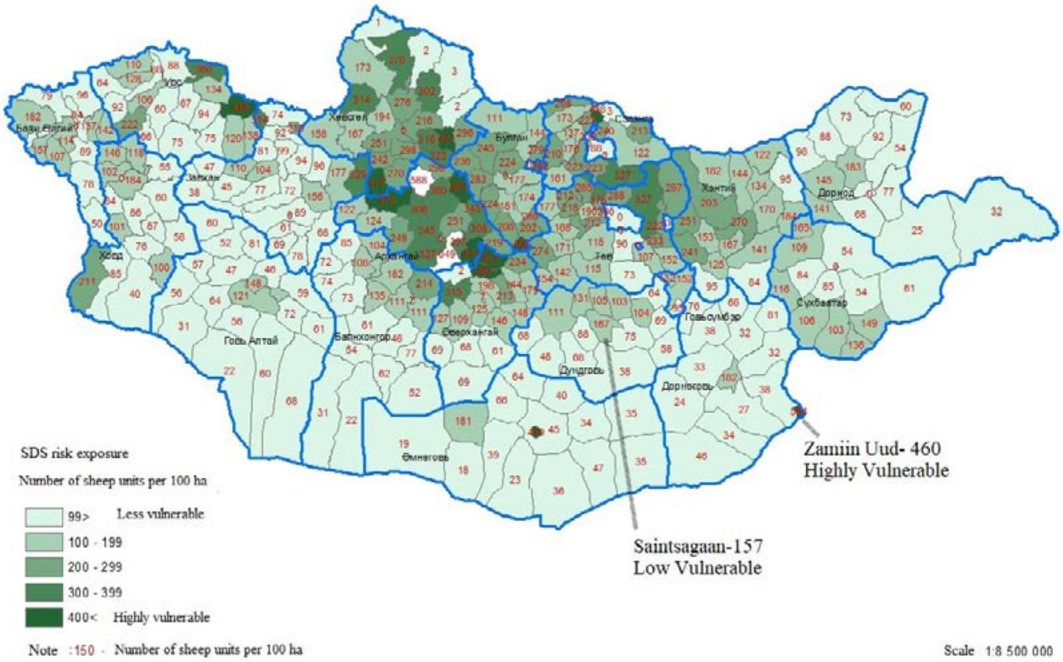




Source: Author's own elaboration

Animal stocking rate was one of the indicators used to assess exposure to SDS risk. The map presented in Figure 4.4 shows that the exposure caused by high stocking rates, calculated as the number of animal sheep units per 100 ha, is very high in Zamyn-Uud *soum*, while it is much lower in Saintsagaan *soum* (see Figure 4.4).

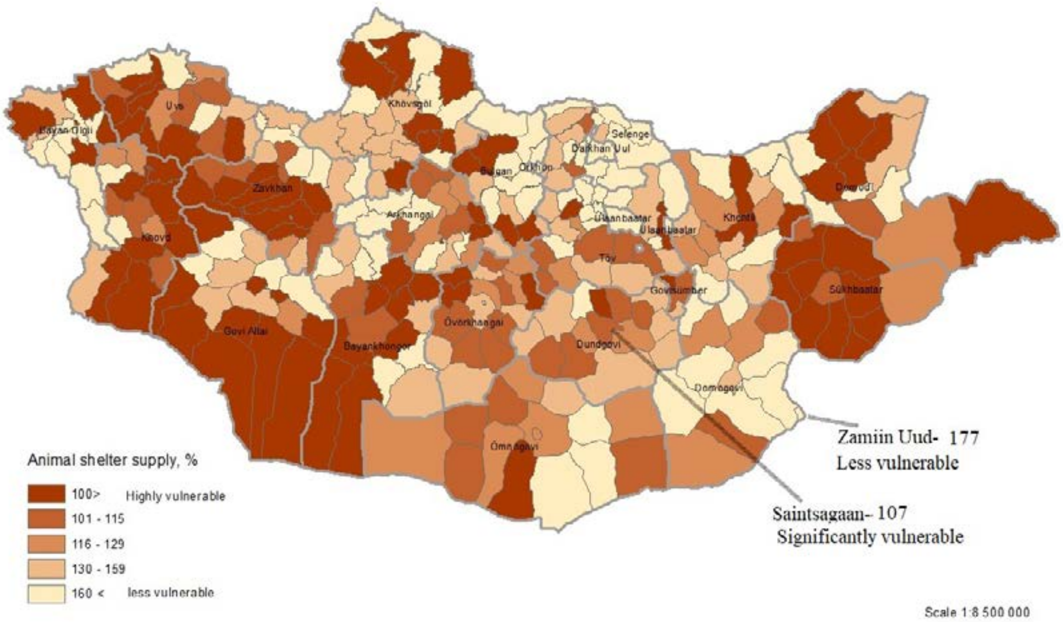
Figure 4.4 | Animal stocking rates to assess exposure to SDS risk



Source: Author's own elaboration. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The animal shelter supply, which was used as an indicator of existing coping capacities, was quite high in Zamyn-Uud *soum* and much lower in Saintsagaan *soum*, showing low and medium vulnerability in the respective *soums* (see Figure 4.5).

Figure 4.5 Animal shelter supply map of Mongolia with the pilot *soums* indicated

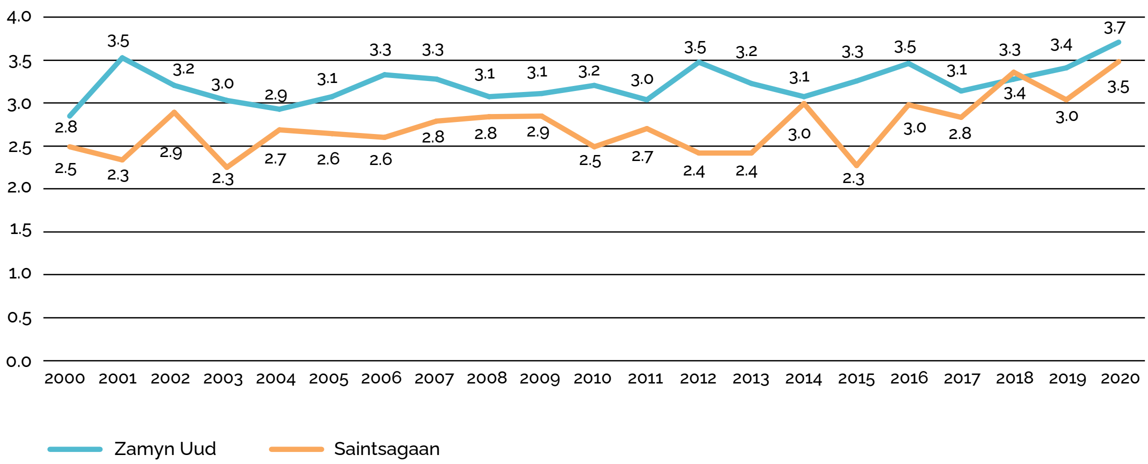


Source: Author's own elaboration. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The consolidated scores for the indicators were calculated and weighted alongside the data presented in Table 3.1. The averages calculated across all indicators were then transferred to three risk and vulnerability classification scores for the past 20 years: low SDS risk (1), moderate risk (2) and high risk (3), as shown in Table 4.1. This integrated classification has clear limitations in terms of expressing absolute SDS occurrence and impact level. However, as a planning tool, it allows a comparison – in relative terms – between *soums* and *aimags* in view of priority setting for SDS risk-informed planning and action.

As seen in Figure 4.6, the weighted average score of all indicators shows that SDS risk has increased in both *soums* over the past 20 years. Given the slightly decreasing trend of SDS severity (Figure 4.2), this shows that variables such as herder vulnerability may have more profound impacts, which increase the levels of SDS risk, than does the hazard severity itself.

Figure 4.6 | Sand and dust storm risk assessment in two *soums*, with weighted average score under the five-score system



Note: Because of data availability some variables were taken as constant across years; this can be corrected for future assessments.

Source: Author's own elaboration

The year 2020 was classified as a high-risk year due to a severe SDS event in March 2021 (see Section 4.2 for details of SDS events in the two *soums*). Table 4.1 presents the consolidated application of the indicators over a two-decade period to provide an overview of the yearly risk levels faced by the two *soums* during the past 20 years. This long-term perspective helps the *aimag* administration to prioritize their assistance for SDS and DRR across various *soums*.

Table 4.1 | Sand and dust storm risk classes by years, 2000–2020

Risk classes		Zamiin Uud	Saintsagaan
1.6–2.5	Low risk	-	2000, 2001, 2010, 2012, 2013, 2015
2.6–3.5	Moderate risk	2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	2002, 2004, 2005, 2006, 2007, 2008, 2009, 2011, 2014, 2016, 2017, 2018, 2019, 2020
3.6–4.5	High risk	2020	

Source: Author's own elaboration

Mongolia's national and local (*aimag* and *soum*) stakeholders as well as the FAO team were consulted on the model and its results for the two selected soums.

4.2 Towards sand and dust storm risk management planning

A sample *soum* SDS risk management plan was developed based on the baseline study findings. The draft plan was agreed with stakeholders in the two *soums*.

A disastrous SDS event on 14 March 2021 highlighted the critical importance of national and local SDS contingency planning among herding communities. The event had a wind speed of 28–34 m/s and visibility of less than 5 m that continued for 6–10 hours and covered several *aimags*. The event had serious impacts on herders, especially in Saintsagaan *soum*, where 86.7 percent of households experienced livestock deaths; 65.2 percent lost livestock in the storm, 55.7 percent of which have not been found; 5.4 percent had their *d* destroyed; and 34.4 percent lost family members during the event. Ninety percent reported that their pasture vegetation had blown away, 89.9 percent had their pastures buried by sand and 51.9 percent experienced a temporary loss of phone networks.

As a result, herders in the Saintsagaan *soum* lost 3.3 percent of their camels, 1.8 percent of their horses, 12.6 percent of their cattle, 16.1 percent of their sheep and 18.1 percent of their goats. Herders in the Zamyn-Uud *soum* lost 1.69 percent of their cattle, 0.14 percent of their sheep and 0.83 percent of their goats.

Herders in the two *soums* experienced significant losses, because 79.5 percent did not expect the severity of the disaster; 64.4 percent of herders were unable to find their herds in the very low visibility caused by the event; 56.1 percent were unable bring their livestock to the camp before the loss of visibility; and 14.7 percent had ignored weather forecasts.

The March 2021 event yielded some key lessons, which led to concrete suggestions for the contingency planning that followed: 84.7 percent of the herders in the two *soums* highlighted the importance of monitoring and acting on weather forecasts; 64.7 percent observed that livestock should be kept close to shelter and that herders should be on alert to immediately chase livestock to camps; 56.2 percent indicated that hay and other feed should be reserved to feed livestock when they are sheltered; 42.5 percent noted that shelters should be insulated better; and 29.3 percent highlighted that the *ger* carcass and posts of enclosures should be well fixed with good materials. Some 53.5 percent expressed the need to learn how to use phones enabled with the Global Positioning System (GPS).

The herders suggested that it is essential for weather forecasts to inform them about SDS duration (73.8 percent), possible darkness caused by SDS (71.8 percent) and changes in wind direction (37.5 percent). Most herders (92 percent) also highlighted the importance of having GPS or phones with GPS to help with locations and directions in the typically flat and featureless Gobi landscape during low visibility SDS events.

4.2.1 Sand and dust storm institutional planning framework

The following legal instruments underpin the development and implementation of *soum* SDS risk management planning:

- Law on Administrative and Territorial Units of Mongolia and their Governance, Clauses 59.1.12, 59.1.13 and 59.1.31
- Law on Disaster Protection, Clauses 32.1.1, 32.1.6, 32.1.7 and 32.1.12
- Law on Hydro-Meteorology and Environmental Monitoring, Clauses 7.1.3 and 7.1.4
- Budget Law, Clause 60.2.8
- National Program for Participatory Disaster Risk Reduction, approved by Government Resolution #303 in 2015
- State Emergency Commission approved by Government Resolution #11 of 2008; *aimag* and *soum* governor's action plan for 2020–2024 and relevant provisions of the working procedure of the *soum* emergency commission.

All measures to reduce and mitigate SDS risks should be undertaken in accordance with the general principles and methodology of *soum* risk management planning and implementation.

Implementation responsibilities are proposed as follows:

- The *soum* emergency commission (SEC) is responsible for making sure that the plan is prepared with due consideration of the herders' proposals.
- The *soum* governor is responsible for earmarking adequate financial resources for the plan's implementation in the annual *soum* budget.
- The *soum* governor is responsible for organizing monitoring and evaluation of implementation.

4.2.2 Contingency planning outcome

The objective of contingency planning is to minimize the adverse impacts of SDS events on pastures, livestock and the livelihoods of herders by mobilizing technical and financial resources to better prepare for risks and to enable timely and effective mitigation activities during and after SDS events. Table 4.2 presents a sample SDS in agriculture contingency plan at the *soum* level.

Table 4.2 | Sample SDS in agriculutre contingency plan at *soum* level

No.	Activities	Timing	Responsibility	Notes
1. Ensure better preparedness				
1.1 Activities to improve risk preparedness				
1	Create emergency reserve grazing plots close to winter and spring camps, with fencing and irrigation.	Annually, April – August	Herder groups, *khot ails,* herder households and absentee herd owners	
2	Plan and implement measures to expand the contractual use of pastureland by herder groups and to stop and prevent overgrazing of pastureland.	In 2–3 years	*Soum* governor, land officer, bagh governor and leaders of herder groups	
3	Raise the awareness of herders of the need to invest a part of their income in risk preparedness activities,	Annually	Agricultural unit, veterinary unit, herder groups and cooperatives	
4	Organize evaluation of the leeward winter and spring shelters by experienced herders and take measures to help owners to build barriers.	In 1–2 years	*Soum* SEC, herders and land officer	
5	Provide herders and citizens with official information on drought, *dzud* and natural hazard-induced disasters; assess potential risks and ensure that herders take preparedness measures.	When needed	*Soum* SEC	
6	Insure livestock and valuable property.	When available	Herder households and absentee herd owners	
1.2 Activities to address SDS vulnerability				
1	Ensure repair and maintenance of shelters, sheds and other infrastructure (e.g., sand removal and well-draining).	August	Herder groups, herder households and absentee herd owners	
2	Arrange placing of wind barriers and windbreaks to protect winter and spring shelters, sheds and other facilities using naturally- available materials (e.g. rocks and stones).	Annually, April–June	Herder groups, *khot ails*, herder households and absentee herd owners	
3	Take and enforce anticipatory action/preparedness decisions upon receiving SDS early warning information to help protect the animals from the impact of SDS.	When needed	*Soum* SEC, governor's office and agriculture unit	

4	Develop rules for circulating SDS warning information in accordance with the *Soum* SEC decision on the activity in row 3 and update with lessons learned.	When needed	*Soum* SEC and agriculture unit	
5	Promote the use of GPS-equipped phones by herders and provide simple handouts on their use.		Governor's office, *Soum* SEC and bagh governor	
6	Establish *soum* and herder emergency fodder reserves.	Annually, August–November	*Soum* SEC, governor's office and herder households	
7	Organize, repair and fix *ger* structure and lattices, and roofs of livestock shelters, sheds and houses.	Annually, March–June	*Khot ails*, herder households and absentee herd owners	
2. Activities during the SDS event				
1	Ensure horses, camels and off-road vehicles are ready and available to search for lost livestock.	When needed	*Khot ails*, herder households and absentee herd owners	
2	Store petrol/fuel reserves.	When needed	Herder households	
3	Ensure warm clothes, boots and other facilities and food are ready and available.	Annually	*Khot ails*, herder households and absentee herd owners	
4	Identify and map leeward places where livestock that have gone downwind can be kept and inform herders about how these places can be reached.	When needed	*Soum* SEC, bagh governor, *Khot ails*, herder households and absentee herd owners	
5	Move sheep and goats to nearby pastures or shelters as soon as an SDS warning is received.	When needed	*Khot ails*, herder households and absentee herd owners	
6	Keep camel, cattle and horses in low-wind pastures or sheds.	When needed	*Khot ails*, herder households and absentee herd owners	
7	Make feed available for livestock that are fenced up (soaked of bran and granulated feed, water)	When needed	*Khot ails*, herder households and absentee herd owners	
8	Ensure prompt access to information about unexpected changes in wind speed and direction and visibility, and deliver it to appropriate persons.	When needed	*Soum* SEC and bagh governor	
9	Protect young and small animals kept in shelters from being killed by mounting each other by regularly checking on them.	When needed	Herders	
10	Promptly notify *Soum* SEC and related personnel if any person is lost.	When needed	Herders and absentee herd owners	
11	Report to *Soum* SEC if livestock has gone downwind or has been lost.	When needed	Herder households and absentee herd owners	

3. Follow-up activities after SDS events				
3.1 Activities to reduce SDS impacts				
1	Promptly organize searches for lost humans and livestock.	When needed	*Soum* SEC, herder households and absentee herd owners	
2	Take immediate measures to bury and destroy carcasses of dead animals.	When needed	Veterinary unit, herder groups, herder households and absentee herd owners	
3.2 Other activities				
1	Estimate SDS damage and loss at the *soum* and bagh administrative unit within the *soum* level	Annually	Herder households, absentee herd owners, agriculture unit, SEC and insurers' agents	
2	Request the provincial governor's office, non-governmental organizations, humanitarian organizations and international bodies for necessary assistance for affected households	When needed	Governor's office and *Soum* SEC	

Source: Author's own elaboration

Note: A khot ail is a herding camp.

Chapter 5.
Conclusions and recommended next steps

5.1 Conclusions

The SDS hazard in Mongolia has been relatively well studied from the scientific perspective. However, neither the impacts of SDS on agriculture nor vulnerability issues have been closely considered. There is a growing recognition that SDS risk assessment must include both long-term trends, such as climate change and land degradation, which affect SDS frequency and severity, and short-term climatic variables, such as wind speed, air temperature and soil moisture, which trigger and shape SDS at a particular time. While mapping tools are commonly used to measure changes in long-term trends, real-time assessments and analyses are needed to forecast short-term climatic variables. Akhlaq, Sheltami and Mouftah (2012) stressed that SDS require continuous monitoring and early warning systems to allow people downwind to take preventive, preparedness and anticipatory action measures that will minimize SDS impact on human health, the environment and the economy.

In this regard, this report has provided insights on the current trends around SDS in Mongolia, in particular on the sources, drivers as well as impacts on agriculture. It has given an overview of the existing policy and institutional framework in Mongolia and has indicated the gaps, challenges, and constraints to the mainstreaming of SDS into the relevant national DRR and sectoral plans, policies and strategies as well as the need to strengthen the mandates, roles and responsibilities of the relevant institutions dealing with SDS in agriculture. The report has further proposed an SDS risk assessment model for livestock herding that uses existing (proxy) indicators to assess hazard, vulnerability, exposure, and coping capacities. This risk model was applied to risk-informed SDS planning in agriculture through providing a sample SDS in agriculture contingency plan at the *soum* level, which outlines the different preventative, preparedness and anticipatory actions to reduce the adverse impacts of SDS on agriculture. In the following section, the recommended follow up actions are provided to scale up SDS contingency planning and implementation in Saintsagaan and Zamyn-Uud *soums* and in other areas affected by SDS in agriculture.

5.2 Next steps: scaling up actions to combat sand and dust storm for resilience building

5.2.1 Recommended follow-up actions in Saintsagaan and Zamyn-Uud *soums*

As discussed in Section 2.5, the two *soums* face enormous difficulties in adopting and implementing SDS contingency planning.

It is thus recommended that a team of national technical experts undertake a field mission in the *soums* to: (i) raise awareness of the need for SDS contingency planning; (ii) identify key challenges and potential solutions to adopting contingency planning and ensuring its technical, and institutional and financial sustainability; and (iii) agree with local governments and herders on practical steps to undertake contingency planning.

The baseline study findings and sample contingency plans will provide the basis for initial consultations and feedback from local stakeholders, including the government and herder communities.

It is also recommended that the expert team investigate national and international sources of technical and financial support for the planning exercise to secure the interest of local stakeholders and make consultations with them more focused and effective.

Based on the results of the field mission, the expert team will update sample contingency plans to include detailed responsibilities, funding sources and monitoring and evaluation, as well as mechanisms for coordinating with relevant provincial and national bodies. The activity will involve a series of awareness-building and consultation meetings and workshops. The updated plans will be submitted to the two *soums* for review and approval.

It is envisaged that the contingency plans will be implemented on a pilot basis in the two *soums* for two years, after which they will be incorporated into regular *soum* DRR planning and implementation starting in the third year.

5.2.2 Recommendations for scaling up action to combat SDS in other affected areas

Given the novelty of SDS contingency planning, awareness-building is an essential first step that needs to be carried out in parallel with pilot activities in the two *soums*.

It is recommended that an SDS contingency planning workshop be organized in the first year involving all relevant national and subnational bodies: NEMA, NAMEM, MOFALI, MET and the Agency for Land Management, Geodesy and Cartography. The workshop should aim to: (i) raise awareness of SDS risks to pastures and livestock herding and of contingency planning as a tool to address those risks; (ii) seek and coordinate support from relevant national and provincial bodies for planning activities in the two pilot *soums*; and (iii) establish a task force in charge of coordinating national DRR efforts on SDS until they are incorporated into regular civil service and budget funding.

It is recommended that the task force lead the process of SDS contingency planning and the coordination of efforts by individual institutions, including consideration of updated functions and job descriptions through consultation workshops and meetings. It is highly likely that the task force will need the expert team's support to ensure that relevant institutions and their staff have explicit responsibility for specific tasks on SDS contingency planning, funding, implementation, monitoring and evaluation, data management and interagency coordination.

The task force will inform the expert team on progress in pilot contingency planning activities in the two *soums* on a regular basis; this will feed into the task force's efforts to promote SDS contingency planning and regular updating as needed.

The expert team task will also conduct studies on SDS impacts, especially indirect impacts such as reduced availability of pasture forage and declines in livestock productivity. In addition, the task force will consult internally where this data will be stored to ensure data accessibility as well as identify any institutionalization opportunities for conducting impact assessments more regularly.

It is recommended that the SDS risk assessment model and contingency planning process be reviewed for eventual replication in other *soums* of Mongolia affected by SDS. It is expected that the task force will depend heavily on the recommendations of the expert team for the development of the replication plan. The replication is expected to take place in the third or fourth year, depending on the results in the pilot *soums* and the outcome of technical capacity-building and activities to secure funding.

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