WATER-RELATED CLIMATE HAZARDS IN MONGOLIA

Introduction

Mongolia is already experiencing significant impacts from climate change, including a rise in average temperatures by over 2°C in the past 70 years, leading to more frequent and intense extreme weather events such as heatwaves, droughts, floods and Dzuds. The country's vulnerability is further exacerbated by its arid environment and uneven distribution of water resources, with regions like the Gobi Desert receiving little rainfall annually.

Climate change poses severe threats to agricultural productivity, livestock management, and local communities, making it crucial for Mongolia to implement comprehensive adaptation measures. The agricultural sector is particularly vulnerable due to changing precipitation patterns and extreme weather events, which can lead to reduced crop yields and increased soil erosion. Livestock management is also heavily impacted, as harsher winters and more frequent droughts threaten the health and survival of animals, thereby affecting the livelihoods of herders.

Key hazards identified

The research identified three primary climate-related water hazards for Mongolia: droughts, riverine floods, heatwaves and Dzuds. This report differentiates between three severity categories[1] of these hazards – low, medium and high – and provides a projected probability of occurrence for each of these categories for each year in the period 2024-2100. To display the range of future scenarios, three climate change scenarios are used: SSP5-8.5 (high-emission scenario), SSP2-4.5 (moderate-emission scenario), SSP1-2.6 (low-emission scenario). The risks and impacts of the climate hazards vary significantly depending on emission pathways. Detailed findings for each hazard are described in the following.

Droughts: Mongolia is already experiencing significant drought pressure, with the probability of low-hazard drought events at approximately 14% per annum, medium-hazard events at 3%, and high-hazard events at less than 1% as of 2024. Under the SSP 1-2.6 scenario, the likelihood of all droughts is projected to remain relatively stable with slight variations, ending the century at around 16%, 4%, and less than 1% for low (see Figure 1 for the time series), medium, and high-hazard events, respectively. The SSP 2-4.5 scenario shows similar projections, with stable drought hazard levels and a slight increase at the end of the century to 20% (Figure 1), 6%, and 1%, respectively.

[1] Hazard severity classification was defined based on a standardized precipitation evapotranspiration index (SPEI) for droughts, composite risk scores for floods and dzuds, and duration for heatwaves.

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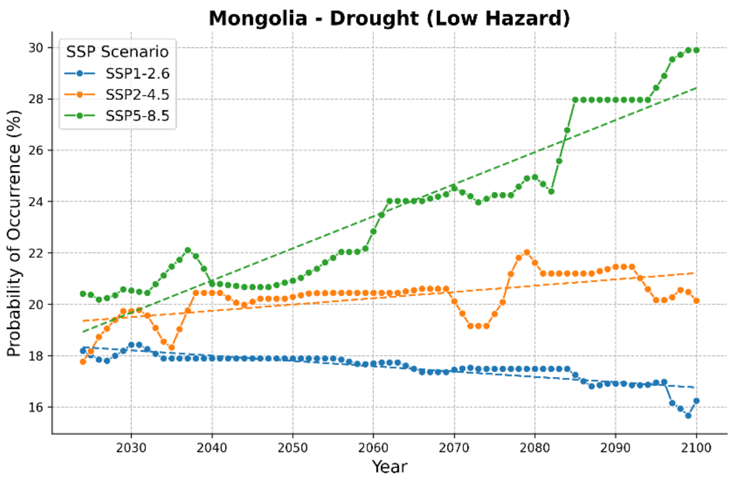
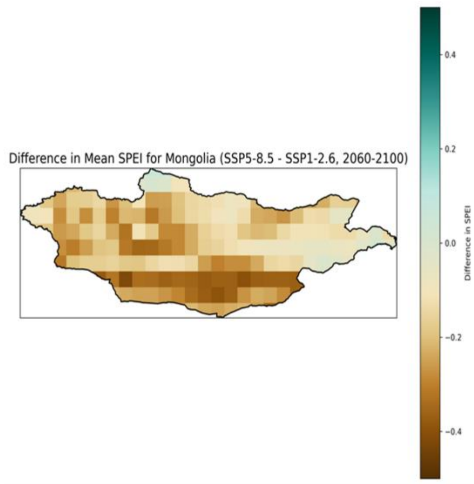
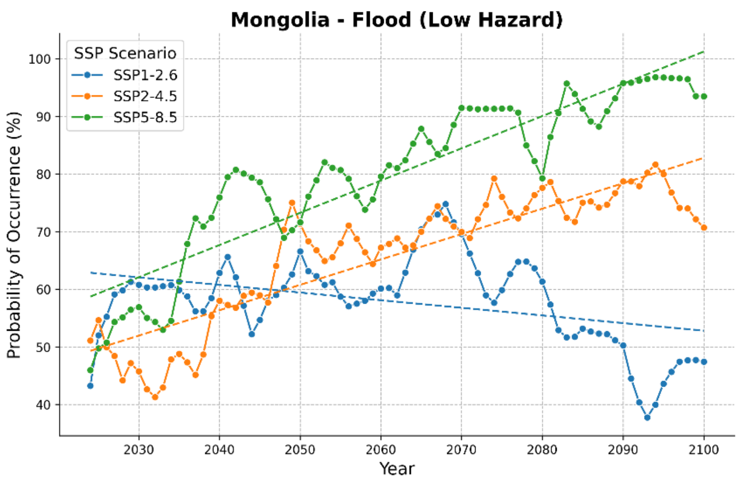
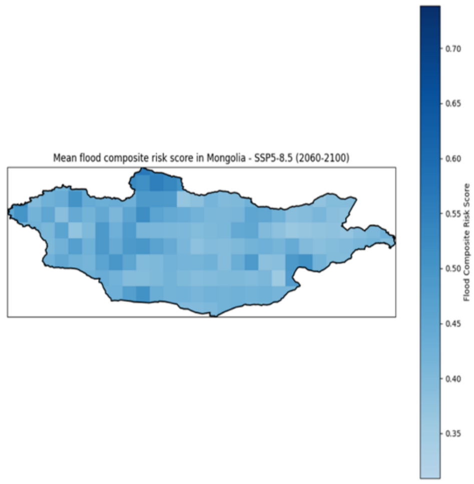
However, under the SSP 5-8.5 scenario, the probability of occurrence increases significantly, with 30% (Figure 1), 13%, and 3%, respectively. Hence, this high-emission scenario will lead to more severe drought conditions and greater damage compared to the other scenarios.





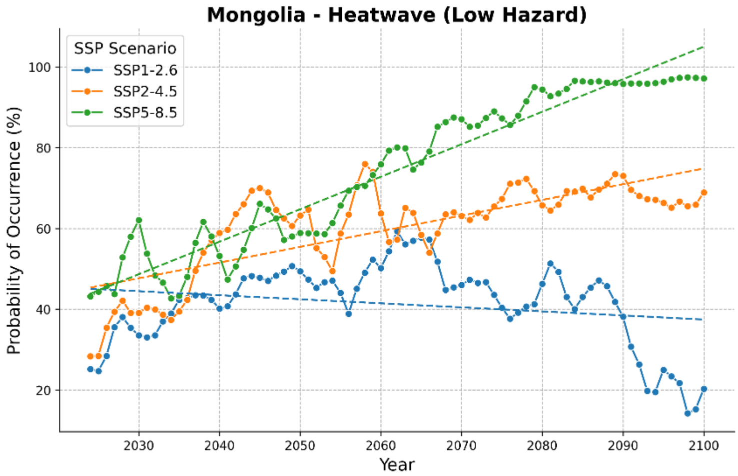
Floods: Mongolia is under substantial flood pressure, with the historical baseline showing a mean probability of occurrence of 20% for low-hazard floods, 10% for medium-hazard floods, and around 2% for high-hazard floods1. By 2024, these numbers changed to around 45% (see Figure 2), 26%, and 5% respectively. Floods are projected to increase in Mongolia. Under SSP1-2.6, the probability of occurrence by the end of the century is around 47% (low-hazard evet, Figure 2), 27% (medium), and 6% (high) respectively. Under SSP2-4.5, the likelihood of floods increases significantly, finishing at around 70% (Figure 2), 48%, and 10%1. Under SSP5-8.5, the probability of floods rises dramatically to around 93% (Figure 2), almost 80%, and 25% respectively.

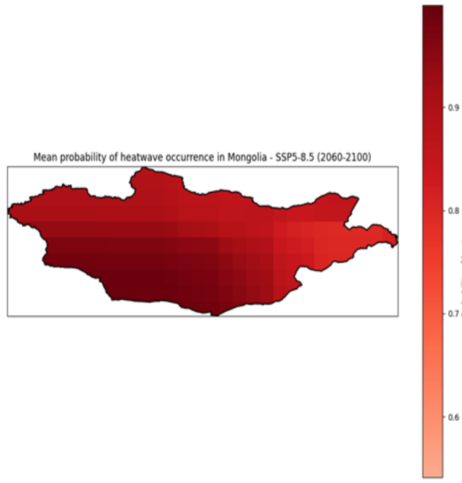




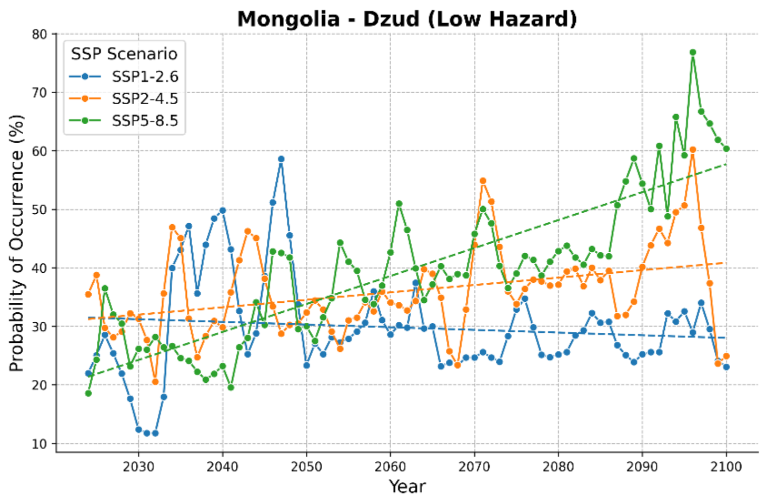
Heatwaves: Mongolia is currently facing heatwave pressure, with the historical baseline showing a mean probability of occurrence of 6% for heatwaves lasting longer than five days (low hazard event), and less than 1% for heatwaves longer than seven days (medium hazard) and ten days (high hazard). All projections show an extreme increase compared to the historical baseline period. Under the SSP 1-2.6 scenario, the probability of occurrence for low-hazard events rises significantly at first but decreases again towards the end of the century, finishing at approximately 20% likelihood (see Figure 3). Medium-hazard and high-hazard events are much less likely under the low emission scenario than in 2024.

Under the SSP 2-4.5 scenario, the probability of occurrence for all three hazard levels is projected to increase significantly and steadily until the end of the century, finishing at around 70% (Figure 3), 30%, and 6%, for the low-, medium- and high-hazard event respectively. Correspondingly, under the SSP 5-8.5 scenario, the likelihood of all three hazard classifications is projected to increase dramatically throughout the entire projection period, with almost 100% (Figure 3), 80%, and 60%, respectively. Hence, this high-emission scenario will lead to more severe heatwave conditions and greater damage compared to the other scenarios.





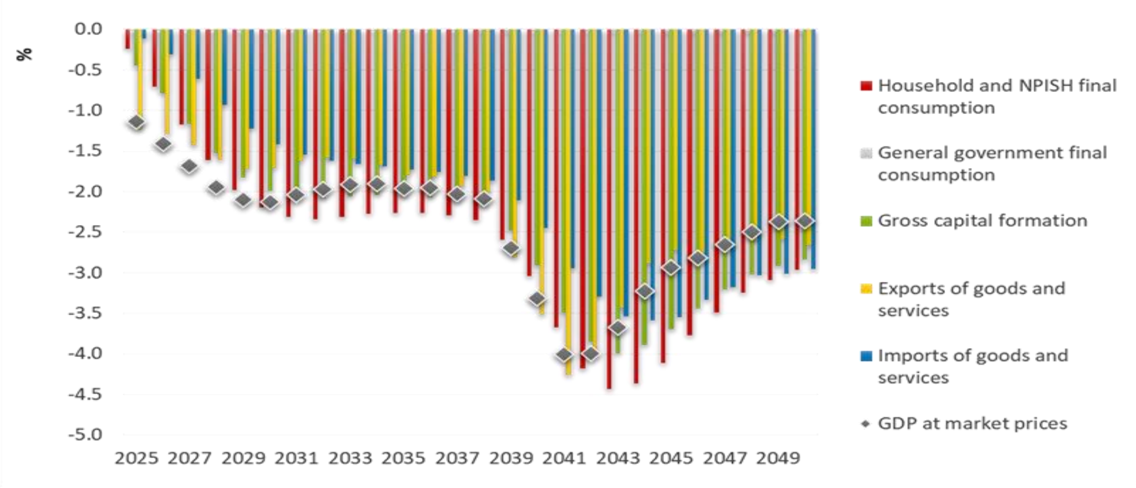
Dzud: Mongolia is currently facing significant Dzud pressure, with the historical baseline showing a mean probability of occurrence of 20% for low-hazard Dzud events, 10% for medium-hazard Dzud events, and around 2% for high-hazard Dzud events. The hazard classifications correspond approximately to 5-year Dzud risks, 10-year Dzud risks and 50-year Dzud events in the baseline period. By 2024, these numbers change to around 25% (see Figure 4), 15%, and 5% respectively. Dzuds, characterized by harsh winter conditions following summer droughts, are projected to increase in Mongolia. Under SSP1-2.6, the probability of occurrence decreases by the end of the century to 25-30% for the low-hazard event (Figure 4), 18% for the medium-hazard, and 5% for the high-hazard event as compared with 2024. Under SSP2-4.5, the likelihood of Dzuds increases significantly, finishing at around 40% (Figure 4), 27%, and 10%, respectively. This shows that this scenario will increase all hazard Dzud events. Under SSP5-8.5, the probability of Dzuds rises strongly to around 60% (Figure 4), almost 45%, and 25% respectively. The findings correspond to international projections and estimations that Dzuds will deteriorate in Mongolia, in particular if global efforts are not increased to fight the effects of climate change, which can be seen for the SSP5-8.5 scenario in the second half of the century. The effects become particularly visible beyond 2050 due to cumulative emissions and delayed responses in climate system.



Economic impacts

The agriculture sector, a critical component of Mongolia's economy, faces significant threats from prolonged droughts and extreme weather events, which could severely impact food security and economic stability. Livestock herding, a major livelihood for many Mongolians, is particularly vulnerable to water scarcity and harsh winter conditions known as Dzuds, leading to substantial livestock losses and economic hardship. Additionally, increased flooding due to changing precipitation patterns and glacial melting poses a risk to urban infrastructure, especially in Ulaanbaatar, potentially causing widespread damage and escalating maintenance costs. These climate-related water hazards underscore the urgent need for comprehensive adaptation measures to safeguard Mongolia's economy and livelihoods.

Economic impacts of climate change – SSP5-8.5 scenario (Source: GWS based on e3.mn)

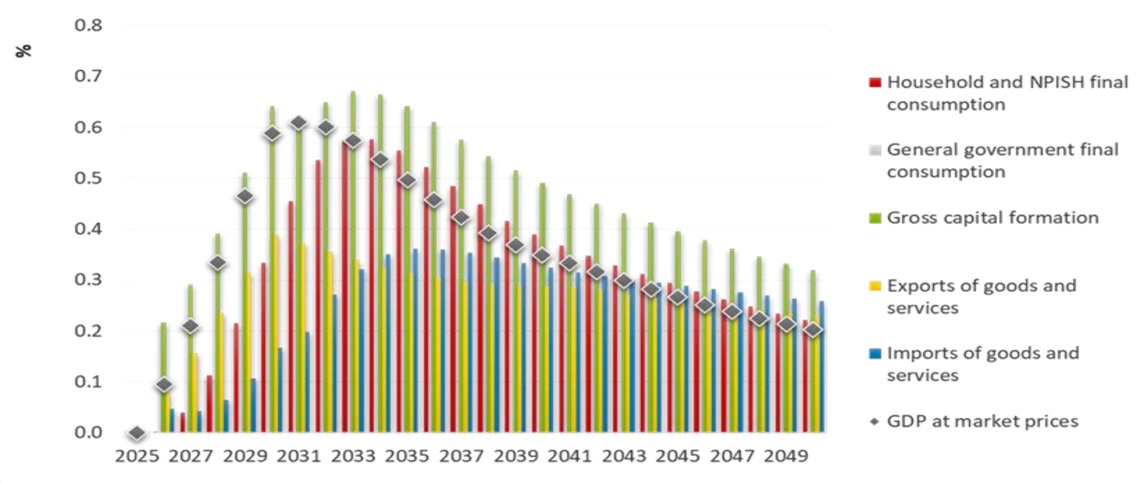


Adaptation strategies

Immediate action is recommended to both mitigate greenhouse gas emissions and adapt to the most likely climatic hazards riverine floods, heatwaves, droughts and Dzuds, to prevent further economic damages.

As part of its Nationally Determined Contribution Action Plan, Mongolia is planning to expand permeable and drip irrigation systems. A macroeconomic analysis carried out by GIZ evaluated the broader economic benefits of drip irrigation. The findings demonstrate that strengthening resilience to water scarcity can drive job-rich economic growth, with GDP increasing by up to 0.6% annually and employment by up to 7,000 per year until 2050.

Economic benefits of drip irrigation – SSP5-8.5 scenario (Source: GWS based on e3.mn)



According to an analysis of the literature and expert interviews, further possible adaptation measures are the following. The implementation of integrated water resources management (IWRM) can optimize the use of water, land, and related resources, enhancing economic and social welfare while preserving vital ecosystems. Sustainable pasture management practices, such as rotational grazing and reseeding, will support livestock herding and reduce the risk of Dzuds, ensuring economic stability. Further, climate-resilient fodder protection strategies, such as establishing regional fodder banks and introducing resilient fodder crops, will improve livestock survival during harsh winter conditions as fodder is stored for these events. Ecosystem restoration initiatives, including reforestation and wetland rehabilitation, will bolster resilience against climate change. Promoting efficient water use practices, such as rainwater harvesting and improved irrigation techniques, will address water scarcity and enhance agricultural productivity. Additionally, the introduction of mobile greenhouse systems can provide a controlled environment for growing plants, offering year-round use and water efficiency. Investments in climate-resilient infrastructure, such as flood-resistant roads and bridges, will be essential to reduce economic losses and ensure long-term sustainability in the face of escalating climate risks. Lastly, developing early warning systems and emergency response plans for extreme weather events will provide critical lead time for disaster response, minimizing damage and loss of life.

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The contents of this factsheet are the sole responsibility of the authors and can in no way reflect the official opinion of the GIZ project.

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