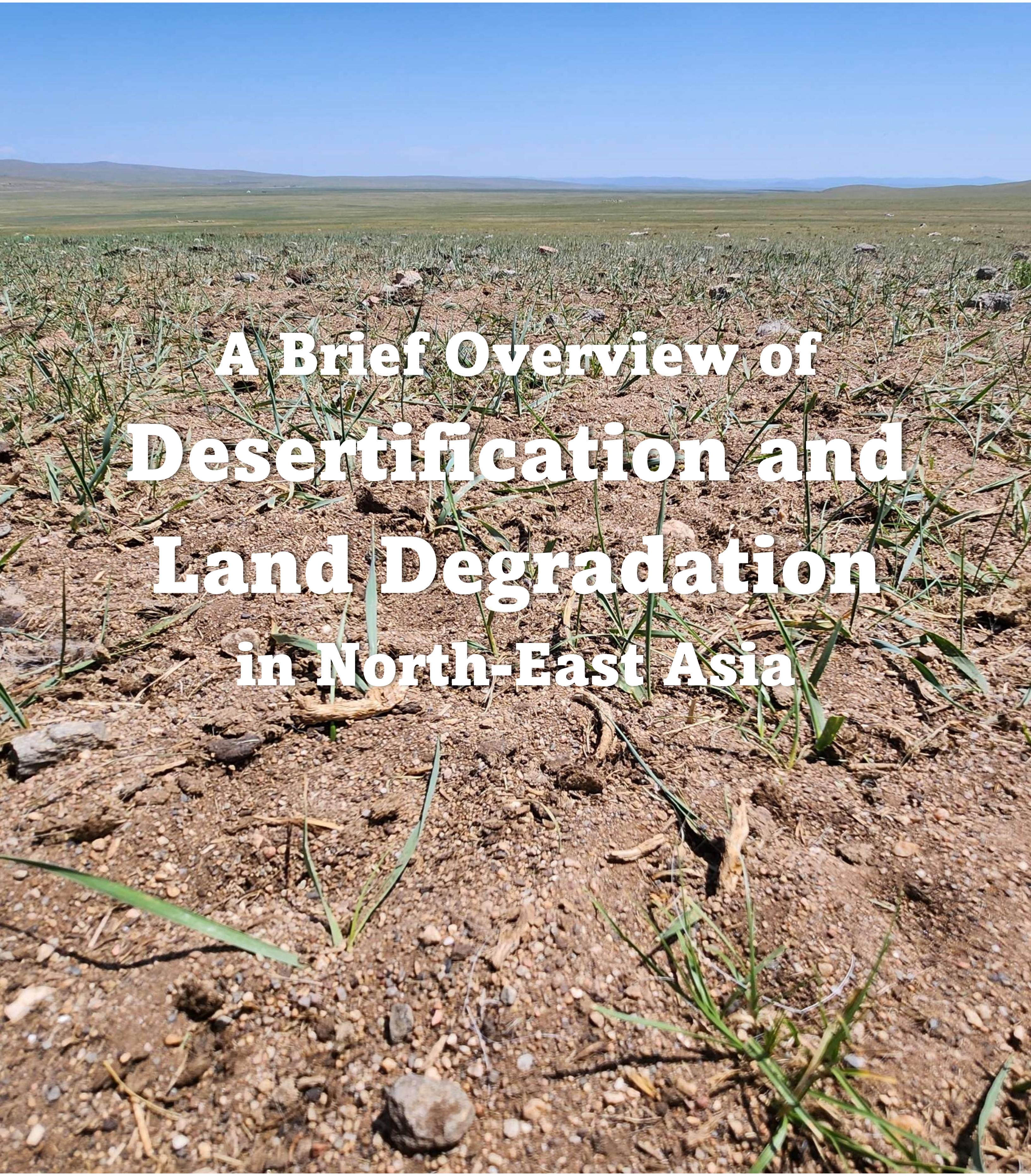

A Brief Overview of Desertification and Land Degradation in North-East Asia

ESCAP
Economic and Social Commission for Asia and the Pacific

NEASPEC
North-East Asian Subregional Programme for Environmental Cooperation

Acknowledgement

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Introduction

Desertification can be understood as the process of *“land degradation in arid, semiarid, and dry sub-humid areas resulting from various factors, including climatic variation and human activities”* (UN, 1994). While there are still some debates, there is a common understanding that socio-economic factors and climatic conditions play an irreplaceable role in exacerbating and mitigating Desertification and land degradation (DLD).

DLD also poses a significant challenge to achieving sustainable development goals (SDGs), particularly SDG 15: Life on Land, among others. Over the past years, DLD has affected over 2.6 billion people in more than 100 countries globally (Rachele, 2020). Among them, 1.5 billion people’s livelihoods have been seriously impacted and are at risk (UN, 2012). Estimates also predict that more than 135 million people will be displaced by 2045 due to DLD (Zarza, 2019). DLD simultaneously impacts the environment, economy and society. As productive land is crucial for providing essential resources such as food, water, wood, and soil nutrients, DLD that reduce the biological and economic productivity of lands can threaten the production of basic land-based resources and thus exacerbate poverty and economic instability in the affected areas. Addressing DLD is, therefore, vital for maintaining ecological balance, supporting economic growth, and ensuring the well-being of communities in the areas at risk.

Many areas are exposed to the risk of DLD in North-East Asia,[1] for instance, the Taklimakan Desert in China and the Mongolia Plateau.

- In **China**, more than a quarter of its territory is covered by desert (World Bank, 2019) and most DLD occurs in the northern part of China, namely Gansu, Inner Mongolia, Ningxia and Xinjiang. More than 90 per cent of these regions display high aeolian activity and are classified as sandy desertification areas (Wang et al., 2009). Such large-scale desertification led to over 60,000 ha of arable land being lost annually due to soil erosion and stagnant per capita grain output and economic indicators in desertified areas (CCICCD, 2017).
- In **Mongolia**, DLD is one of the critical challenges threatening sustainable development. It is estimated that 77.8 per cent of Mongolia’s total land area is impacted by degradation. Of this, 35.3 per cent is considered slightly degraded, 25.9 per cent moderately degraded, 6.7 per cent severely degraded, and 9.9 per cent extremely degraded (UNCCD, 2019).
- The **Russian Federation** reported that 75 per cent of arid lands were affected by desertification in 2000, accounting for 7.5 per cent of the entire territory (Government of the Russian Federation, 2018).
- The **Democratic People’s Republic of Korea (DPRK)** experienced a declining forest area of 12.7 per cent in the past three decades (from 1990 to 2020), damaging the already struggling economy and food security (FAO, 2020a; Genevieve, 2022).
- **Japan** and the **Republic of Korea (ROK)** have a less profound domestic impact from DLD. Nevertheless, the negative impacts of DLD spill over to neighbouring countries, including through dust and sand storms from arid and semi-arid areas.

[1] In this paper, North-East Asia refers to six countries: China, the Democratic People's Republic of Korea (DPRK), Japan, Mongolia, the Republic of Korea (ROK), and the Russian Federation.

While examining the general trend of DLD over the past decades in North-East Asia, the paper reviews socio-economic factors and climatic conditions contributing to it. The paper considers population growth, animal husbandry, water withdrawals, and mining, as well as variations in precipitation, temperature, and wind speed, in association with climate change, as key factors impacting DLD.

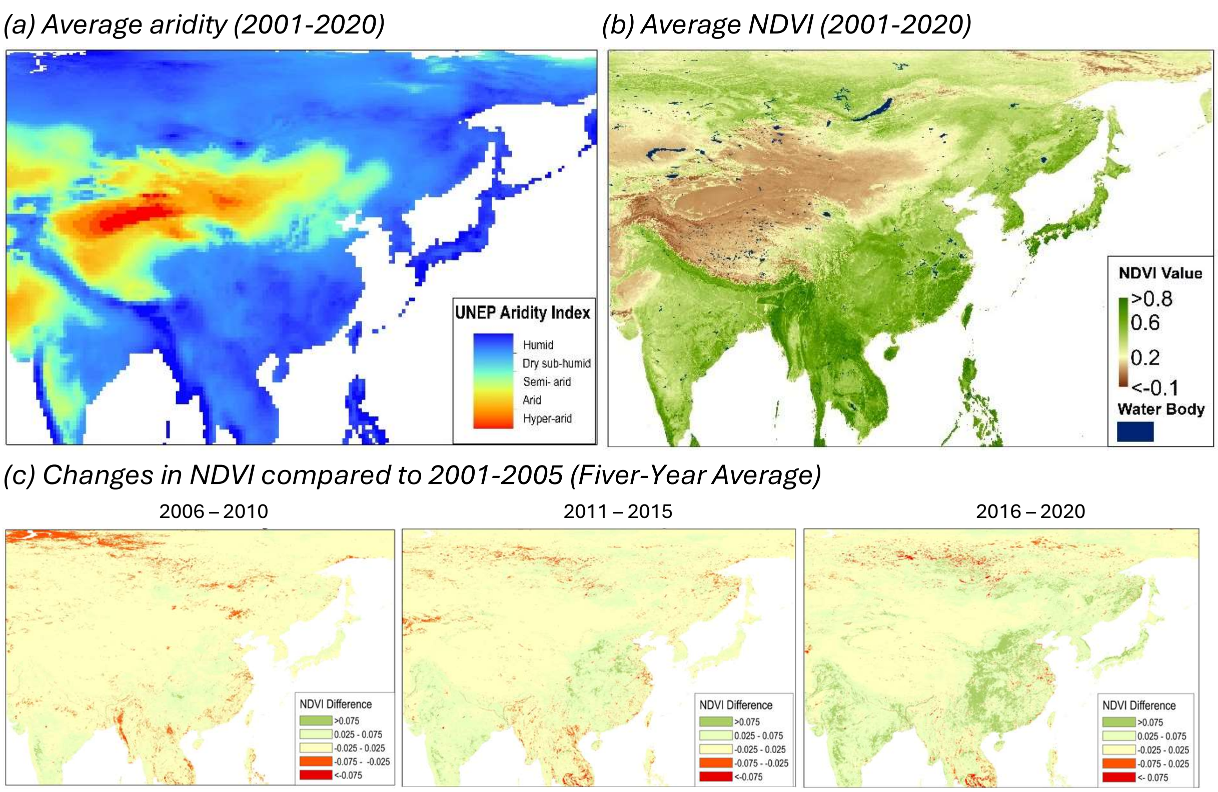
1. Overview of DLD Trends

1.1 North-East Asia

In North-East Asia, arid and semi-arid areas, measured by the Normalized Difference Vegetation Index (NDVI), have slightly decreased from 2001 to 2020, but with exceptions.[2]

Figure 1.1(a) presents the distribution of aridity in North-East Asia. Figure 1.1(b) demonstrates the distribution of average NDVI between 2001 and 2020 in North-East Asia, and Figure 1.1(c) depicts changes in NDVIs in the period 2006-2010, 2011-2015 and 2016-2020 respectively, compared to the baseline (the five-year average NDVI of 2001-2005). In the subregion, large areas in the north-western part of China, Mongolia, and some parts of the Russian Federation are arid and semi-arid.

Figure 1.1 Aridity and NDVI in North-East Asia



Data source: CRU TS Dataset Published by Harris et al. (for aridity), and *USGS (Landsat 8)* (for NDVI)

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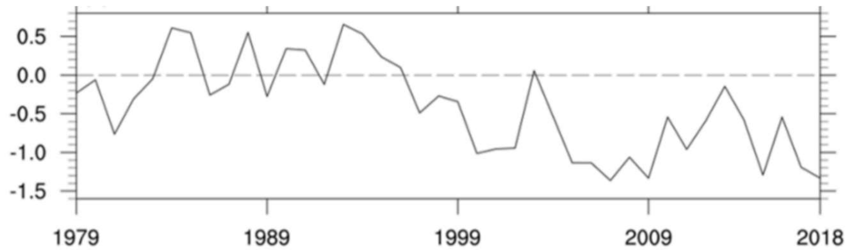
[2] *NDVI is used to reflect the vegetation cover and extent of land degradation, but it also has limitations in terms of not reflecting soil moisture content, distinguishing between different types of vegetation, and accurately capturing seasonal variations. Additionally, errors can occur due to the resolution of satellite images and atmospheric conditions.*

While vegetation improved in many sub-humid and humid areas from 2006 to 2020 compared to the average 2001-2005, progress in dry and semi-dry areas has been somewhat limited. Also, while recurring or long-term drought events can lead to DLD, drought severity in North-East Asia, measured by the Standardized Precipitation Evapotranspiration Index (SPEI), has generally shown increasing trends in the last four decades (Sun et al., 2021).

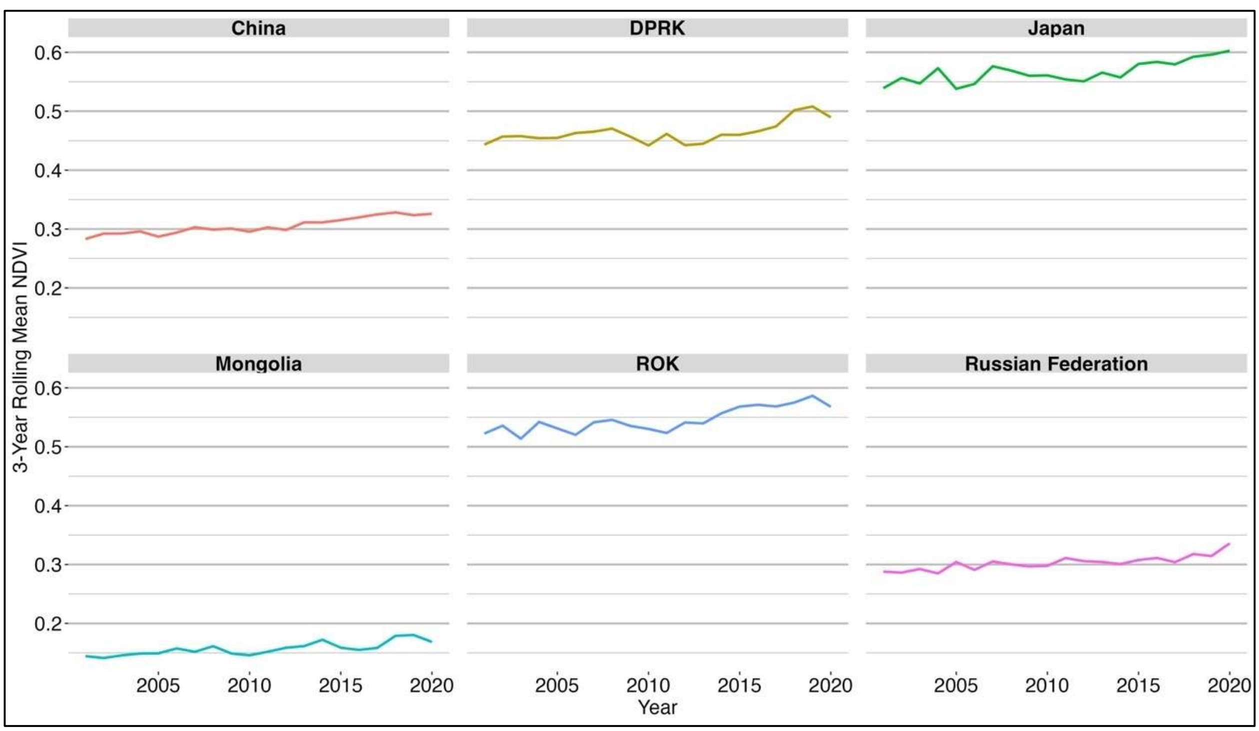
Figure 1.2 SPEI in North-East Asia from 1979 to 2018



Source: Sun et al., 2021

The average NDVI of each country between 2000 and 2020 (Figure 1.3) demonstrates gradual but limited improvements. All member states in North-East Asia have experienced slight increases in vegetation index during this period. However, there are quite big differences in the average NDVI among countries in the subregion. Mongolia showed the lowest level of vegetation cover in the subregion, followed by China and the Russian Federation.

Figure 1.3 Average NDVI of Countries in North-East Asia (2001-2020)



Data source: United States Geological Survey (USGS), Available at: https://lpdaac.usgs.gov/products/mod13q1v006/ (Accessed on 5 August 2024)

1.2 China

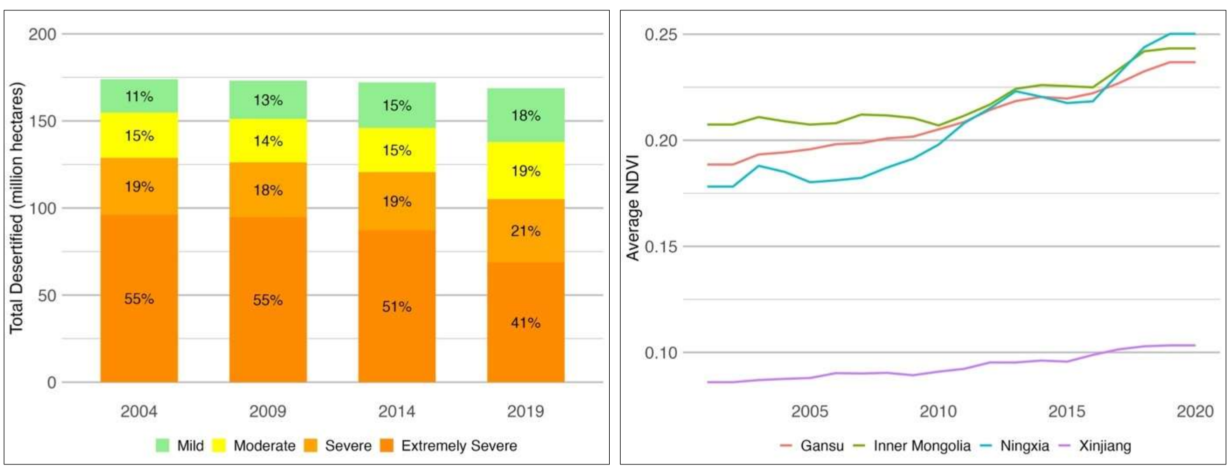
China experienced rapid desertification, but the situation has improved in recent decades.

It was reported that desertification expanded rapidly in China between 1980 and 1990(Li et al., 2021). However, the speed of desertification slowed down from 1990 to 2005, while the overall situation improved in the Yellow River Basin (Jiang et al., 2023). Areas reporting a recovery from desertified lands have increased during the last two decades(Duan et al., 2019; Jiang et al., 2023; Meng et al., 2021a; UNCCD, 2019; Xu et al., 2024; Zhang et al., 2020). Desertified lands have decreased from an annual expansion of 343,600 ha (5.15 million mu) at the end of the last century to an annual reduction of 667,000 ha (10 million mu) in recent years. As a result, between 2000 and 2020, China's vegetation coverage in desert areas increased by 3.2 per cent, with a net reduction of 5.53 million ha (82.95 million mu) of desertified areas (National Forestry and Grassland Administration, 2022).

While the situation differed across the country, arid and semi-arid areas in northern provinces showed gradual progress during this period. As presented in Figure 1.4, Gansu, Inner Mongolia, Ningxia, and Xinjiang also recorded an increase in average NDVI between 2000 and 2020, with some fluctuations. It is also worth noting that the increase in these provinces has accelerated in the recent decade.

Figure 1.4 Desertified Areas in China and NDVI of Gansu, Inner Mongolia, Ningxia and Xinjiang

(a) Total desertified areas *(b) Average NDVI of four provinces*

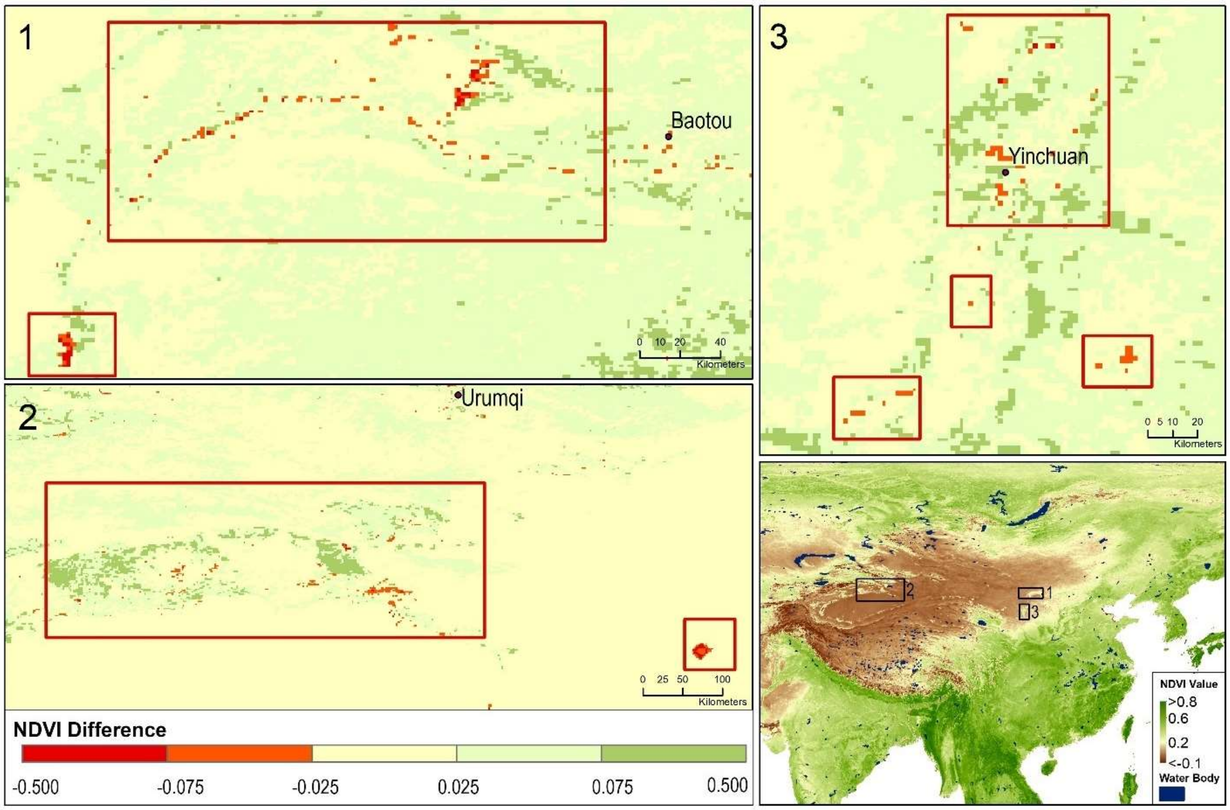


Data source: Desertified area data from China's National Forestry and Grassland Administration (2022), Available at: http://www.forestry.gov.cn/u/cms/www/202309/07095259ryab.pdf (Accessed on 2 September 2024); and Average NDVI data from USGS, Available at: https://lpdaac.usgs.gov/products/mod13q1v006/ (Accessed on 5 August 2024)

Nevertheless, there are still areas requiring further attention.

As a matter of fact, several areas, including the areas near Baotou in Inner Mongolia, Urumqi in Xinjiang, and Yinchuan in Ningxia, experienced a deterioration in the vegetation index from 2000 to 2020, indicating the need for continued monitoring, assessment, and possible interventions in these areas (Figure 1.5).

Figure 1.5 Vegetation-Deteriorated Areas in China



Data source: United States Geological Survey (USGS), Available at: https://lpdaac.usgs.gov/products/mod13q1v006/ (Accessed on 5 August 2024)
Note: The maps (1-3) show differences in the average NDVI of 2016-2020 compared to 2001-2005 at the right bottom.

During the last several decades, China also experienced notable changes in land cover.

From 1985 to 2019, barren land decreased by approximately 2 per cent (Yang et al, 2021). Efforts to combat desertification, such as *the Grain for Green Program*, contributed to the reduction of barren land and helped stabilize desert-prone areas(Song et al., 2014). During the period, forest areas grew by 4.34 per cent (10.02 million ha), while grasslands (6.23 million ha), wetlands (0.92 million ha), and shrubland (2.59 million ha) declined (Yang et al, 2021). In line with the overarching goal of mitigating DLD, local efforts have been tailored to address specific ecological challenges (Box 1.1 and Box 1.2).

Box 1.1 Ring-Taklamakan Million Acre Windbreak and Sand Control Ecological Project

In Makit County, Xinjiang more than 90 per cent of the total area is a desert. Before 2010, the county's annual average rainfall was only over 50 mm, while the evaporation rate exceeded 2,000 mm and sandstorms occurred on more than 150 days each year. In 2012, a government-led initiative, *the Ring-Taklamakan Million Acre Windbreak and Sand Control Ecological Project* (环塔百万亩防风固沙生态建设工程), was initiated in Makit County through the plantation of 410,000 acres of forest, creating a vital ecological barrier that has improved local environmental conditions. The project also contributed to the local economy through forest management modalities for which each household managing the windbreak and sand control forest earned an annual income of approximately 40,000 yuan. This long-term initiative integrates environmental protection and economic development, emphasizing a sustained effort to maintain and expand green spaces in the region.

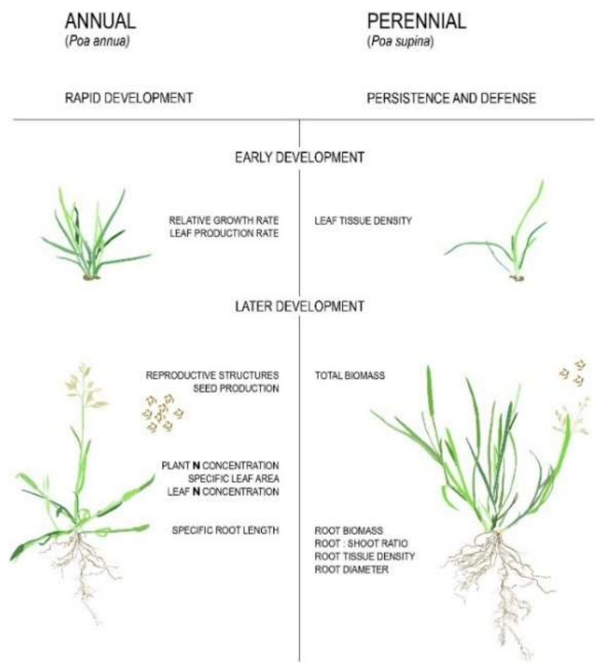
(2012)

(2023)

Source: People.com (2023), Available at: http://cpc.people.com.cn/n1/2023/1201/c64387-40130091.html (Accessed on 23 September 2024)

Box 1.2 Annual and Perennial Plants: An Example from Horqin Sandy Land in Inner Mongolia, China

Physiological differences



Source: Hjertaas et al., 2023

Perennial and annual plants have different impacts on desertification due to their distinct growth patterns. Perennial grasses have deeper root systems, which stabilize soil and maintain soil structure. They are generally drought-resistant and provide year-round ground cover (Ding et al., 2021), thus making the land less vulnerable to extreme conditions. On the contrary, annual plants often complete their life cycle within a year and lack the robust root systems of perennials, but they can quickly cover the soil (Kahn et al., 2011). Their temporary presence leaves soil exposed for some period, potentially worsening desertification if not carefully managed.

In Horqin Sandy Land, strong wind erosion has removed clay and silt particles, resulting in coarse-textured soil that promotes the infiltration of precipitation into deeper soil layers (Cheng et al., 2020). Water in deep soil layers is inaccessible to shallow-rooted grasses but available to deep-rooted shrubs (Walter, 1979). To effectively combat desertification, a strategy that leverages the advantages of both annuals and perennials is suggested. Annual grasses could utilize short-term water availability in upper soil layers(Bardgett et al., 2014; Ning et al., 2022), while perennials can develop deeper roots to access deep soil water. This differentiated growth pattern allows annuals and perennials to coexist. Perennial plants form fertile islands beneath their canopies (Ding et al, 2021).

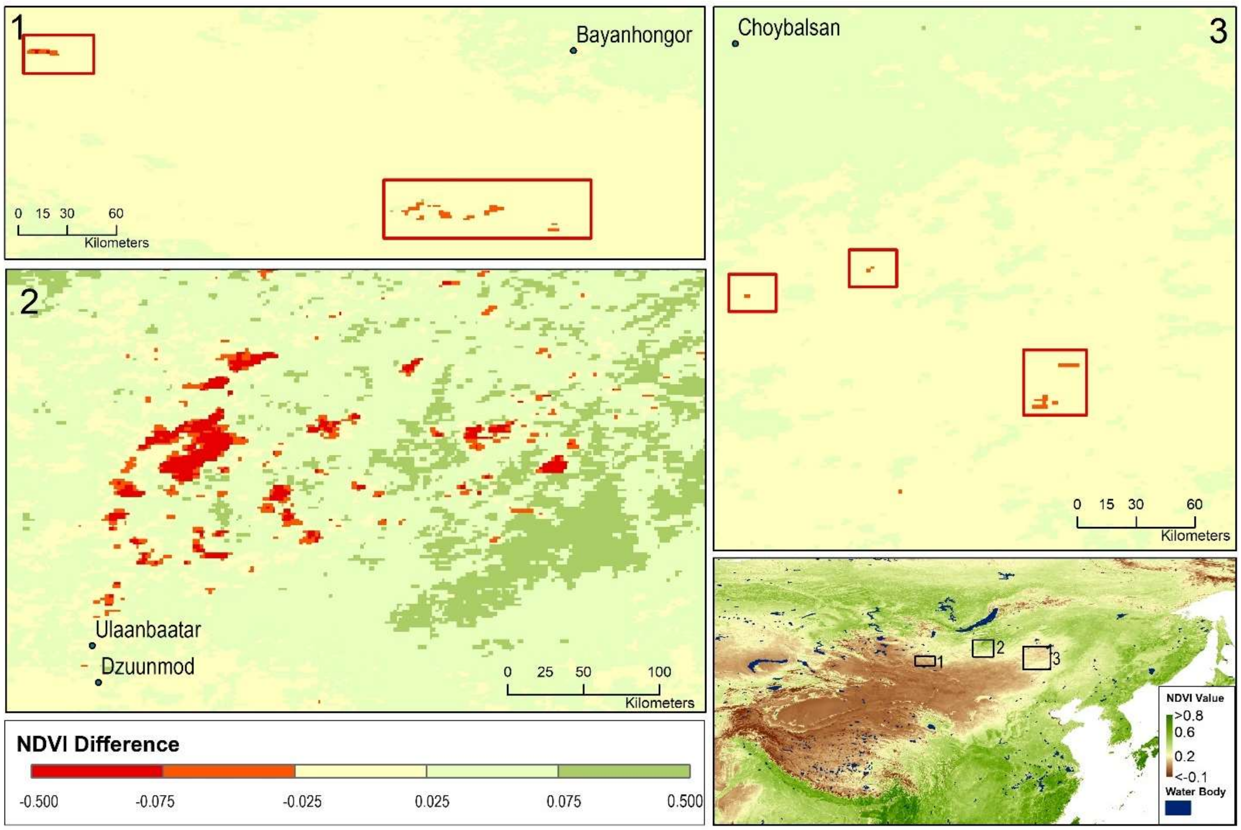
1.3 Mongolia

In Mongolia, the rate of desertification has shown a gradual slowdown since 1990, but changing climate conditions and socio-economic factors continue to exert pressure on arid and semi-arid areas.

The period from 1990 to 2005 saw an increase in desertification, which then slowed from 2005 to 2020 (Meng et al., 2021b; Wang et al., 2017). During the past three decades, average annual precipitation, although with some fluctuations, has not changed significantly. However, the average temperature in Mongolia has risen by approximately 2 degrees Celsius over the past three decades, which is higher than the global average (World Bank Group et al., 2021). These climatic factors combined with the fact that grazing intensity has risen significantly from 40-50 units of average number of livestock per 100 ha of pastureland in 1980-2000 to 60-70 units per 100 ha in 2000-2015 (Mongolian Statistical Information Service, 2021), explain the continued pressure on arid and semi-arid areas.

Mongolia is expected to continue to suffer from the risk of DLD and heatwaves associated with rising temperatures (ESCAP, 2024). Figure 1.6 shows several areas that require further attention on the risk of desertification and land degradation in the country. Several areas in the north of Ulaanbaatar, near Bayanhongor in the West and near Choybalsan in the East, recorded decreasing vegetation in the last two decades. As such, a further assessment of the risk for DLD and close monitoring of the developments in these areas is necessary.

Figure 1.6 Vegetation-Deteriorated Areas in Mongolia

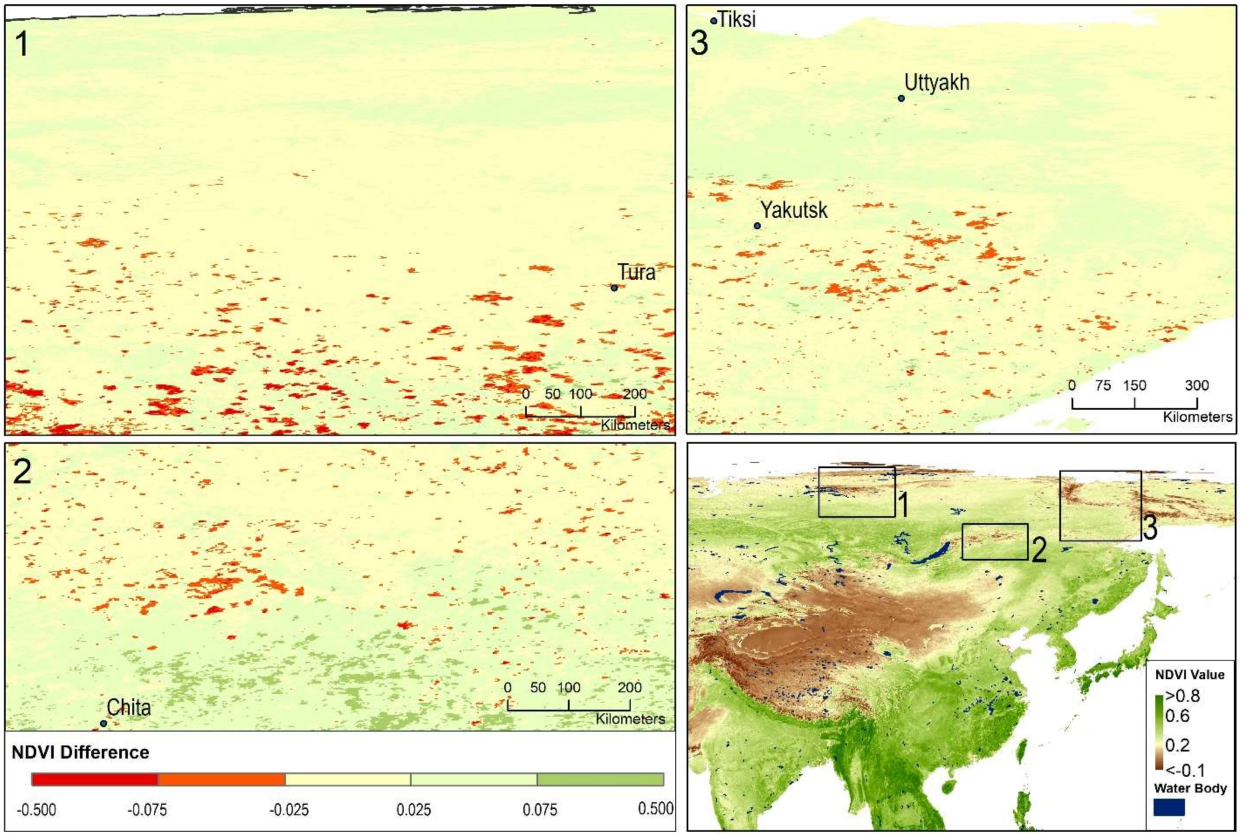


Data source: USGS, Available at: https://lpdaac.usgs.gov/products/mod13q1v006/ (Accessed on 5 August 2024)
Note: The maps (1-3) show differences in the average NDVI of 2016-2020 compared to 2001-2005 at the right bottom.

1.4 The Russian Federation

In the Russian Federation, many parts of arid and semi-arid areas are experiencing a decreased vegetation index. Among others, the western part of Tura, the northern parts of Chita, and the southeastern part of Yakutsk have experienced decreases in NDVI from 2000 to 2020 (Figure 1.7). In addition, it is worth noting that the preservation of unique ecosystems has often been neglected, especially since massive agricultural lands have been leased to foreigners that demand energy and natural resources in the Russian Siberia and Far East (UNCCD, 2019).

Figure 1.7 Vegetation-deteriorated areas in the Russian Federation



Data source: USGS, Available at: https://lpdaac.usgs.gov/products/mod13q1v006/ (Accessed on 5 August 2024)
Note: The maps (1-3) show differences in the average NDVI of 2016-2020 compared to 2001-2005 at the right bottom.

1.5 Other Countries in North-East Asia

In the Democratic People's Republic of Korea, severe deforestation and forest degradation continue to persist, affecting national food security, poverty, and the environment (Laurance et al., 2014; West et al., 2014). According to the Global Forest Resource Assessment of the Food and Agriculture Organization (FAO), forest area has decreased from 6.91 million ha in 1990 to 6.03 million ha in 2020 (FAO, 2020a). In recent years, the government's efforts at afforestation, such as the *Forest Restoration Campaign* launched in 2015, led to a gradual slowdown in the rate of degradation (Choi, 2021).

In Japan, domestic DLD is not a severe problem. As of 2020, the total forest area is 24.9 million ha, which constitutes 66 per cent of its territory (FAO, 2020b). The Ministry of Environment of Japan supports an empowerment project for nomads in Mongolia and contributes to afforestation programmes in other developing countries through technology transfer to combat desertification (Japan's Ministry of the Environment, n.d.; UNCCD, 2019).

In the Republic of Korea, domestic DLD is not significant. In the aftermath of the Korean War, it has promoted a series of reforestation programmes (e.g. restriction on the inflow of firewood to Seoul and other major cities). As of 2020, the ROK’s total forest area is 6.3 million ha (FAO, 2020c). It has also actively contributed to combating DLD in other developing countries, including Mongolia, forming solid synergies in the North-East Asian region. International cooperation can help mitigate the impacts of DLD-related hazards in the Republic of Korea and other neighbouring countries.

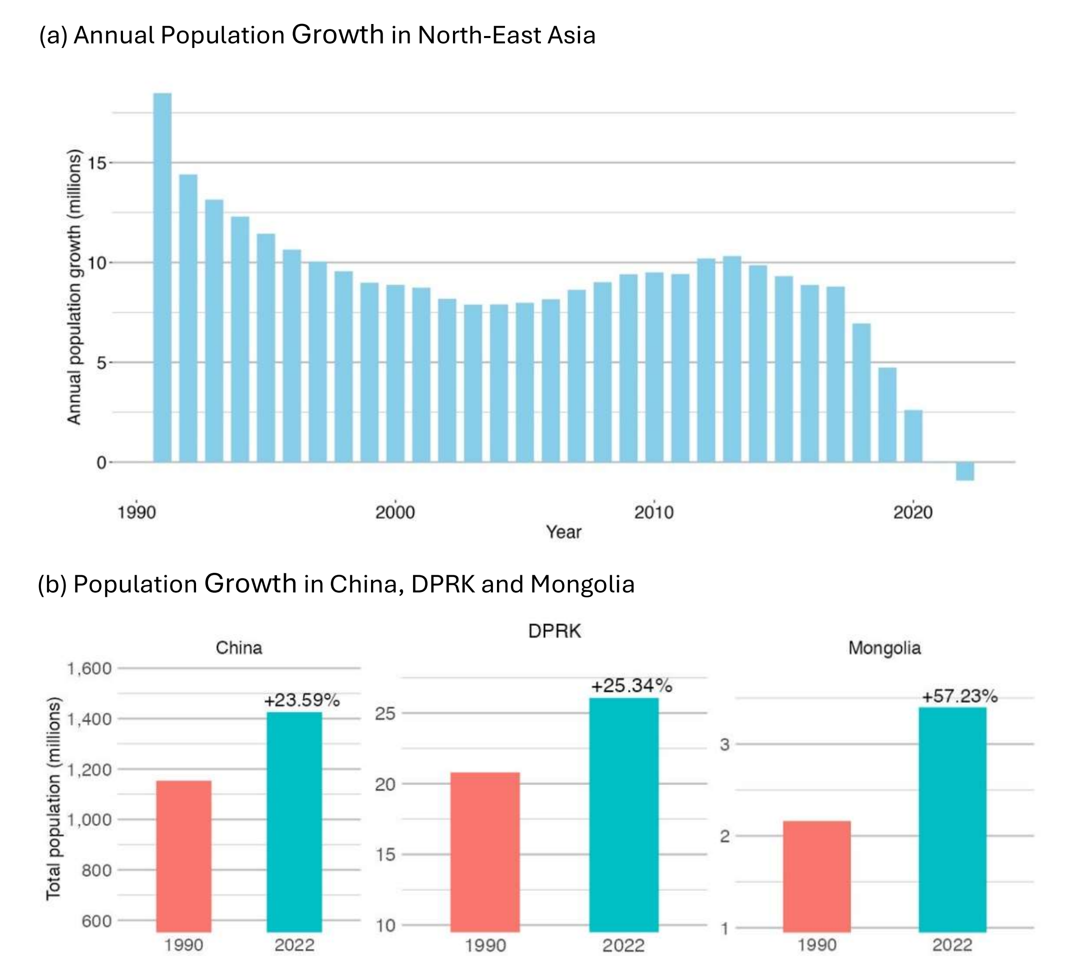
2 Socio-Economic Factors for Desertification and Land Degradation

2.1 Population Growth

Increasing demand for land-based resources associated with population growth is an underlying driver of DLD in North-East Asia.

The total population in North-East Asia has increased from 1.49 billion in 1990 to 1.78 billion in 2022 (ESCAP, n.d.). In particular, the populations of China, the Democratic People's Republic of Korea, Mongolia, and the Republic of Korea have experienced rapid growth during this period, while the sub-regional population growth rate has slowed down in North-East Asia recently (Figure 2.1). Mongolia's population grew significantly from 2.16 million in 1990 to 3.39 million in 2022, a 60 per cent increase, leading to a rapid increase in the consumption of natural resources. The population of the Democratic People's Republic of Korea has also increased from 20.7 million in 1990 to 26.0 million in 2022.

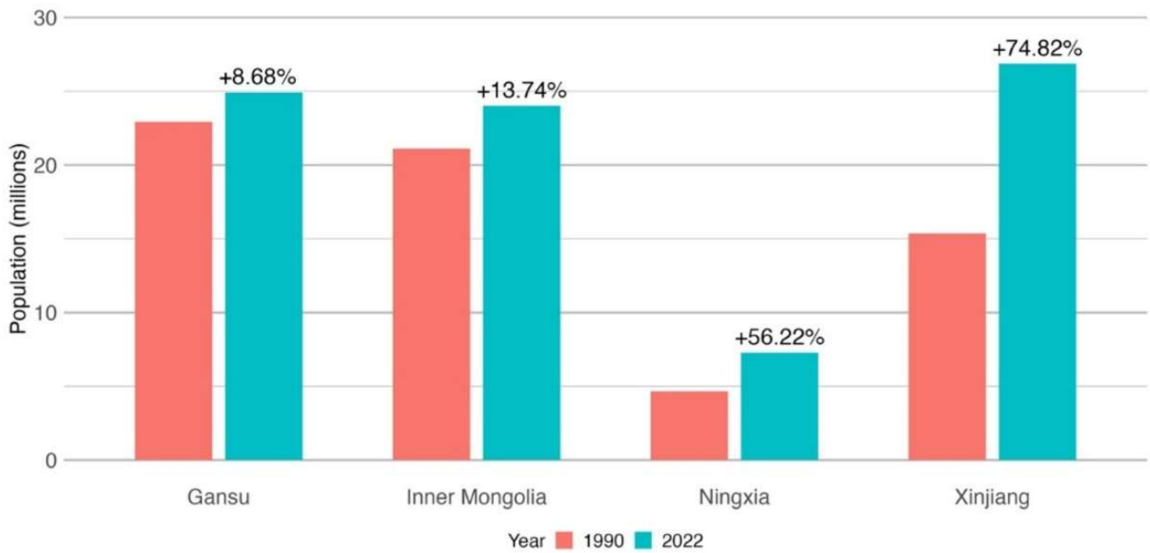
Figure 2.1 Population Growth in North-East Asia (1990-2022)



Data Source: ESCAP SDG Data Gateway, Available at: https://data.unescap.org/home (Accessed in Sep 2024)

In China, the population in 4 northern provinces bearing high risks of DLD has grown substantially in the past decades. Xinjiang recorded the fastest growth rate (74.82 per cent), followed by Ningxia (56.22 per cent), while Inner Mongolia and Gansu have shown gradual population increases (Figure 2.2).

Figure 2.2 Total Populations in Gansu, Inner Mongolia, Ningxia, and Xinjiang in 1990 and 2022

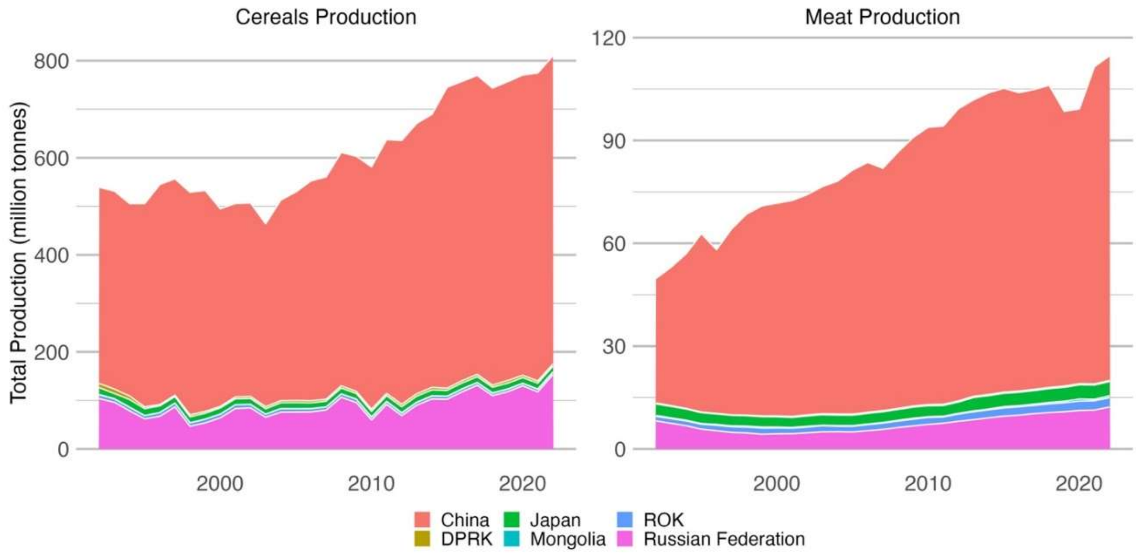


Data source: National Bureau of Statistics of China (2023), Available at: https://www.stats.gov.cn/sj/ndsj/2023/indexch.htm (Accessed on 25 September 2024)

Population growth leads to a greater demand for food, water, and other essential resources for living. If land productivity remains constant, this increased demand requires expanding agricultural land and raising the number of livestock per unit area, among others (Wang et al., 2022).

The increase in the population associated with economic development and changing diets and lifestyles has increased the demand for food and other land-based natural resources in North-East Asia. For instance, over the last three decades, cereal and meat production has surged in the sub-region (Figure 2.3). Total cereal production increased from around 540 million tons per year in 1990 to approximately 800 million tons in 2020, while meat production also jumped from around 50 million tons to over 110 million tons during the same period.

Figure 2.3 Cereal and Meat Production in North-East Asia (1992-2022)



Data source: FAO FAOSTAT (2024), Available at: https://www.fao.org/faostat/en/#data (Accessed on 25 September 2024)

2.2 Animal Husbandry

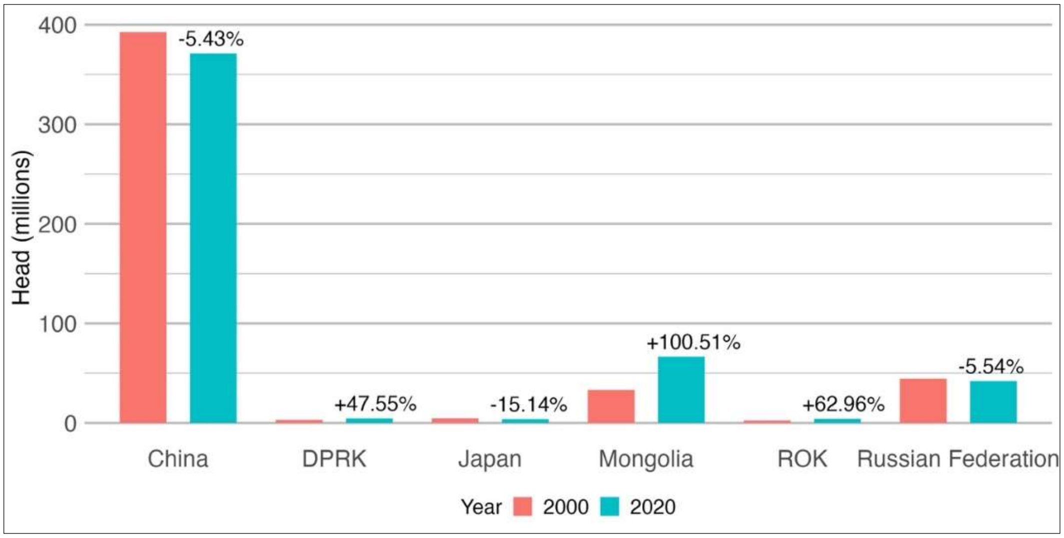
In North-East Asia, in line with the rapidly increasing meat consumption, livestock has significantly increased in recent decades, especially in Mongolia and the northern provinces of China.

In Mongolia, the number of cattle, horses, goats, and sheep doubled between 2000 and 2020 (Figure 2.4). As a result, Mongolia's total livestock number exceeded the pasture-carrying capacity in 2019. More than 70 per cent of pastureland is degraded (UNDP, 2021). It was reported that degradation caused by overgrazing and limited pasture management affected 76.8 per cent of Mongolian territory as of 2015 (International Monetary Fund, 2019).

The Republic of Korea and the Democratic People's Republic of Korea have also experienced rapid growth in the number of livestock (62.96 per cent and 47.55 per cent, respectively) since 2000.

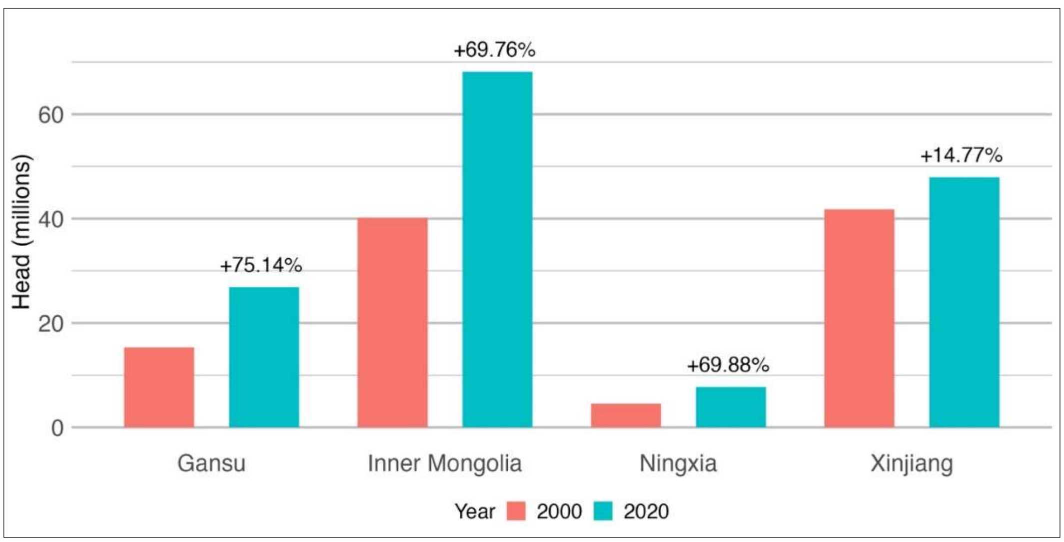
In China, the number of cattle, horses, goats, and sheep has slightly decreased between 2000 and 2020, but four northern provinces with large arid and semi-arid areas – Gansu, Ningxia, Inner Mongolia and Xinjiang – have shown the opposite trend (Figure 2.6). Gansu recorded the highest growth in the number of major livestock over the last two decades, while Inner Mongolia had the largest total number of livestock. The drylands of China have suffered degradation due to increased pressure from livestock populations (Kemp et al., 2013), with the overgrazing rate estimated to be between 22.5 per cent and 89.4 per cent across the country (Zhang et al., 2014). Nevertheless, there have also been notable improvements. For instance, during the last two decades, over 40 per cent of grassland in Xinjiang experienced increasing carrying capacity (Wang et al., 2024).

Figure 2.4 The Number of Livestock in North-East Asia in 2000 and 2020



Data source: FAO FAOSTAT (2024), Available at: https://www.fao.org/faostat/en/#data (Accessed on 15 September 2024)

Figure 2.5 Number of Livestock in Gansu, Inner Mongolia, Ningxia and Xinjiang in China



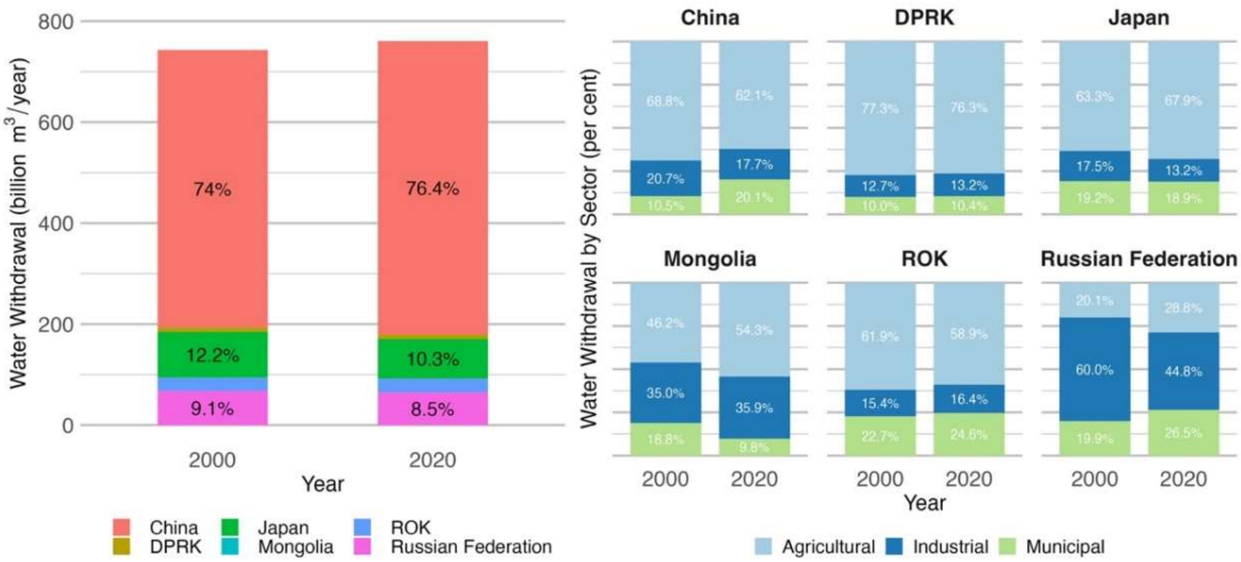
Data source: 2023 Yearbook, National Bureau of Statistics of China (2023), Available at: https://www.stats.gov.cn/sj/ndsj/2023/indexch.htm (Accessed on 25 September 2024)

2.3 Water Withdrawal

Growing population and livestock, and economic progress are often associated with increased water consumption, and this can pose a significant threat to already water-scarce arid and semi-arid areas and raise the risk of DLD. Many countries have already reached the limits of their water resources (UNCCD, 2017), while climate change can further exacerbate water scarcity in many areas. It is reported that globally more than 2 billion people live in countries where total freshwater withdrawals exceed 25 per cent of the total renewable freshwater resources(UNESCO, 2019).

In North-East Asia, countries have experienced mixed trends in total water withdrawals. Reported total water withdrawals has increased over the past two decades in China and the Republic of Korea, while the Democratic People's Republic of Korea, Japan, Mongolia, and the Russian Federation have recorded stable or slightly decreased water withdrawals during the same period (Figure 2.6). Agricultural water withdrawal took the largest portion in all countries except the Russian Federation, while agriculture also consumes soil moisture from naturally infiltrated rainfall on both irrigated and rainfed agricultural land (Rost et al., 2008). Industrial water withdrawal was the highest in the Russian Federation. Notably, municipal water withdrawal more than doubled in China from 2000 to 2020.

Figure 2.6 Water Withdrawal in North-East Asia in 2000 and 2020



Data source: FAO AQUASTAT (2023), Available at: https://www.stats.gov.cn/sj/ndsj/2023/indexch.htm (Accessed on 10 September 2024)

2.4 Mining

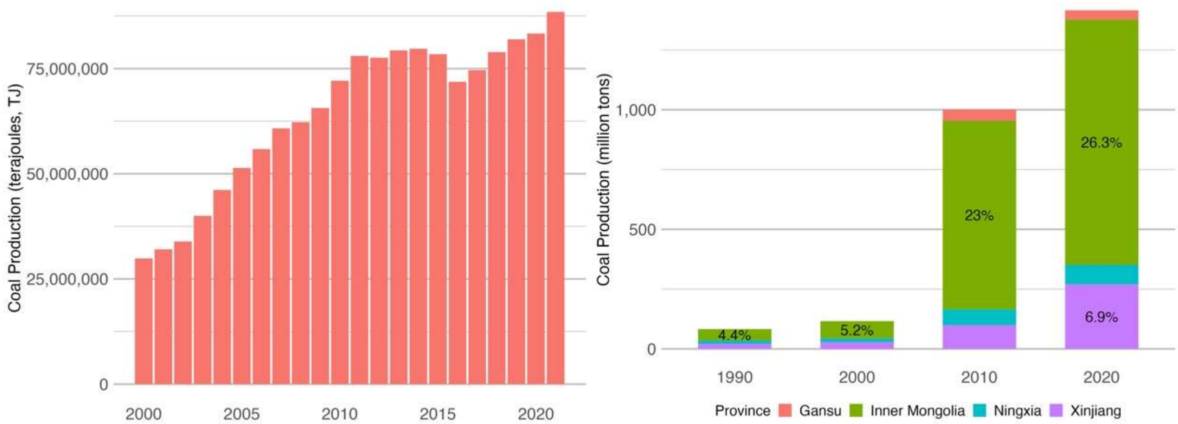
Among others, North-East Asian countries experienced significant environmental challenges associated with mining.

The mining process involves the removal of surface vegetation, the disturbance of land structure, and the pollution of surface and groundwater through waste disposal, all of which contribute significantly to land degradation (Xiao et al., 2020). China has experienced significant land degradation due to mining. Approximately 54 million mu (about 36,000 km^2) of land has been occupied and damaged by mining activities across the country, including 20 million mu (13,334 km^2) affected by ongoing mining operations and around 34 million mu (22,668 km^2) damaged by legacy mines (Ministry of Natural Resources of the People's Republic of China, 2019).[3] For example, coal

[3] Mu is a Chinese unit of land measurement. 1 mu is commonly around 667 m2.

production has increased from 29.8 million TJ in 2000 to 88.5 million TJ in 2020 (Figure 2.7). Among others, coal production in the four northern provinces in arid and semi-arid areas – Gansu, Inner Mongolia, Ningxia and Xinjiang – has substantially increased since 1990. Inner Mongolia recorded an increase of over twenty times in just three decades.

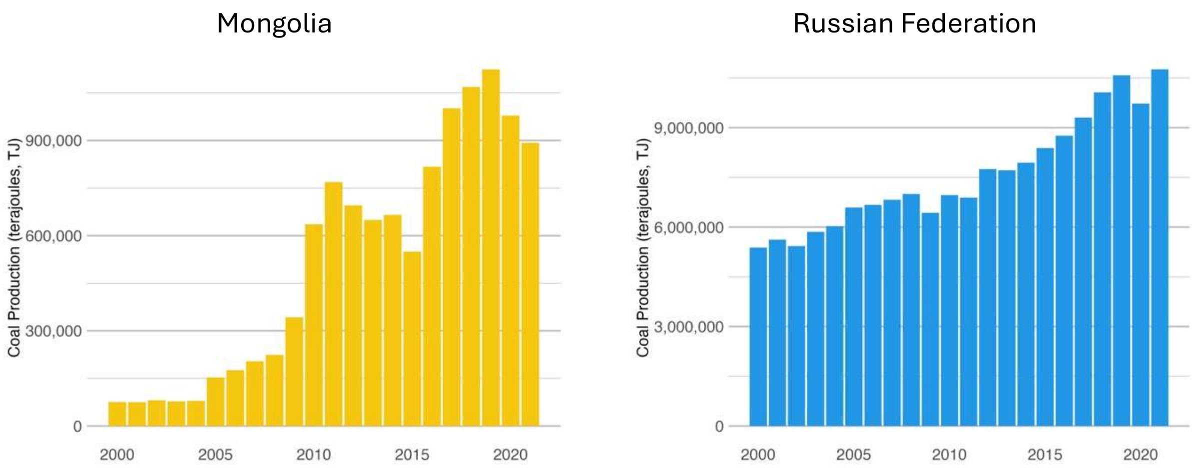
Figure 2.7 Coal Production in China



Data Source: Country-level coal production data from IEA World Energy Statistics and Balances, and Coal production data for Gansu, Inner Mongolia, Ningxia and Xinjiang from 2023 Yearbook, National Bureau of Statistics of China (2023)

Mongolia's mining sector significantly contributes to its economy (i.e. gold, copper and coal) but also poses severe environmental challenges. The extraction processes could lead to substantial land degradation, causing soil erosion, water pollution and deforestation. During the last two decades, coal production has increased by more than 10 times. Coal production in the Russian Federation also nearly doubled during this period (Figure 2.8).

Figure 2.8 Coal Production in Mongolia and the Russian Federation



Data Source: IEA World Energy Statistics and Balances, Available at: https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances (Accessed on 25 September 2024)

3 Climate Change and Desertification and Land Degradation

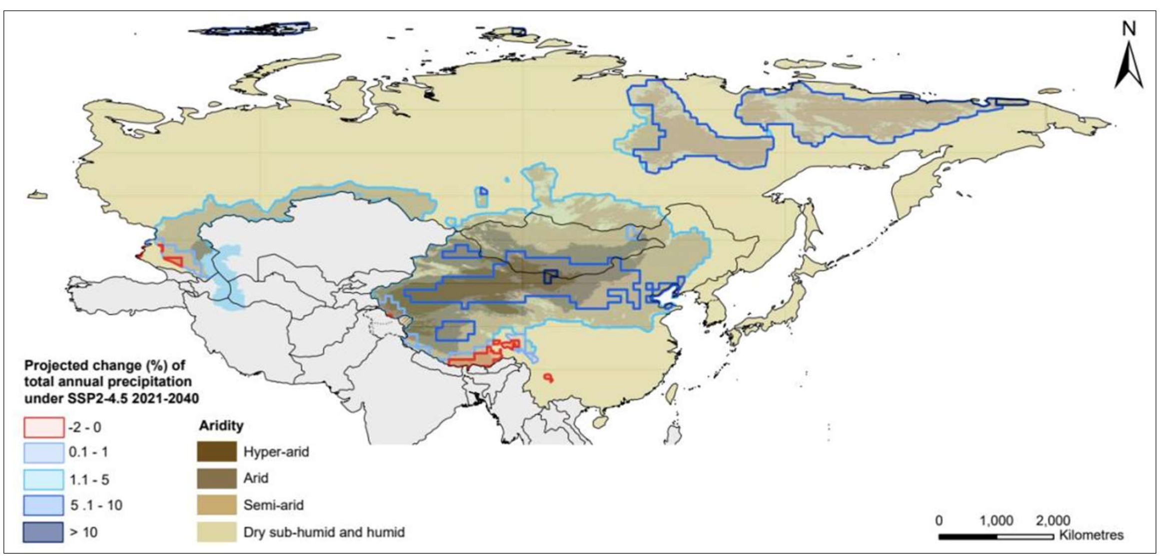
Climatic variables such as precipitation, temperature, wind, and solar radiation play significant roles in desertification and land degradation. They can exacerbate land degradation through increased erosive power of precipitation, water stress from droughts, heat stress, and surface wind speed (Calvin et al., 2023). Thus, it is important to understand the changes in these climatic variables over the next decades to properly assess the risk of DLD in North-East Asia.

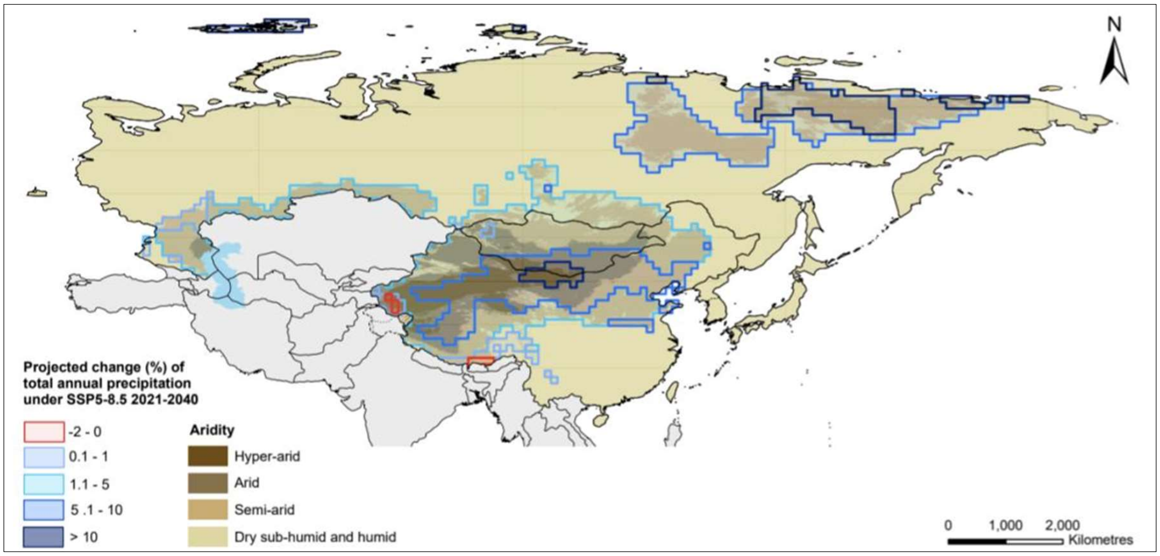
3.1 Precipitation

Recent climate change projections indicate that total annual precipitation in most arid and semi-arid areas of North-East Asia is likely to increase, with some regions—such as Northern China and Southern Mongolia—potentially experiencing increases exceeding 10 per cent.

Although the predicted change in precipitation (2021-2040) shows an increase (Figure 3.1), the absolute amount of precipitation will remain very low. The negligible increase in precipitation is unlikely to have a profound impact on desertification in the arid and semi-arid areas of North-East Asia. Additionally, the intensified hydrological cycle, driven by atmospheric warming, suggests that while the number of heavy rainfall events is expected to increase, the overall frequency of rainfall events might decrease(IPCC, 2022). In general, the effects of precipitation are ambivalent, with both positive and negative impacts. Contextual elements, such as topography, should also be considered to properly understand local impacts from changing patterns of precipitation.

Figure 3.1 Projected Change (%) of Total Annual Precipitation in Hyper-arid, Arid and Semi-arid Areas under SSP2-4.5 (up) and SSP5-8.5 (down), 2021-2040





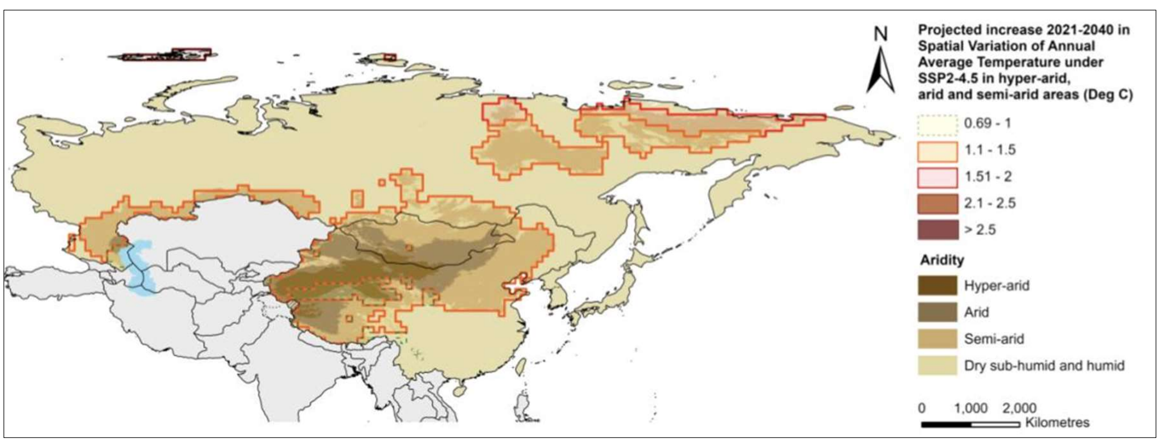
Source: ESCAP (2022) Climate Change and Desertification, Land Degradation and Drought in North-East Asia, submitted to the NEASPEC 25th Senior Officials Meeting, Available at: https://neaspec.org/sites/default/files/2022-09/Item%205%28e%29-Annex%20II%20DLDD%20report_part2_final.pdf

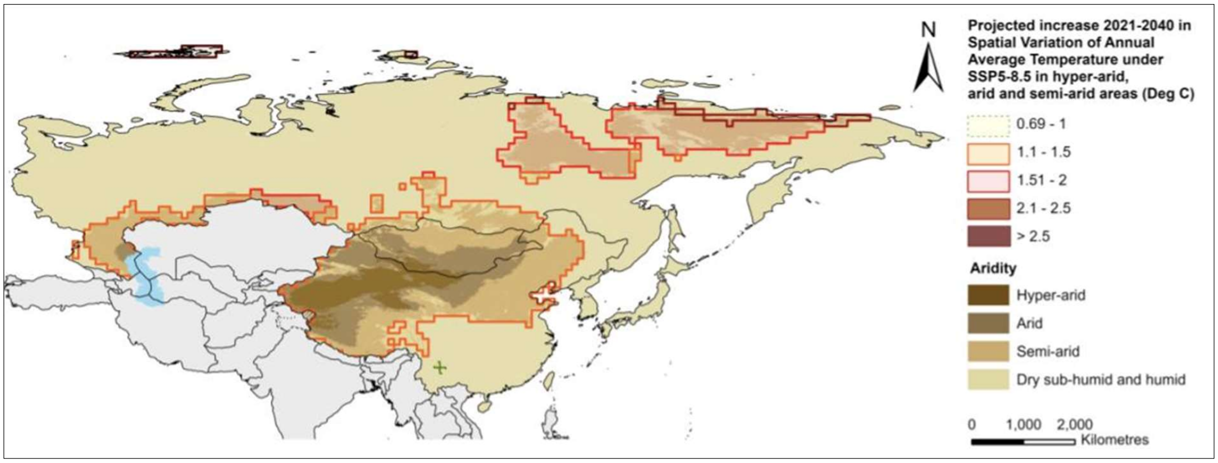
3.2 Temperature

The accelerating temperature increases in many parts of North-East Asia due to ongoing climate change could lead to a decrease in soil moisture, further intensifying desertification (Figure 3.2).

This reduction in soil moisture also contributes to an additional rise in temperature. With less moisture in the soil, the cooling effects typically provided by evaporation diminish. This creates a positive feedback loop in which soil moisture deficits and surface warming reinforce each other, leading to a rapid shift toward a hotter and drier climate in the region (Han et al., 2021).

Figure 3.2 Projected Increase of Annual Average Temperature in Hyper-arid, Arid and Semi-arid Areas under SSP2-4.5 (up) and SSP5-8.5 (down), 2021-2040





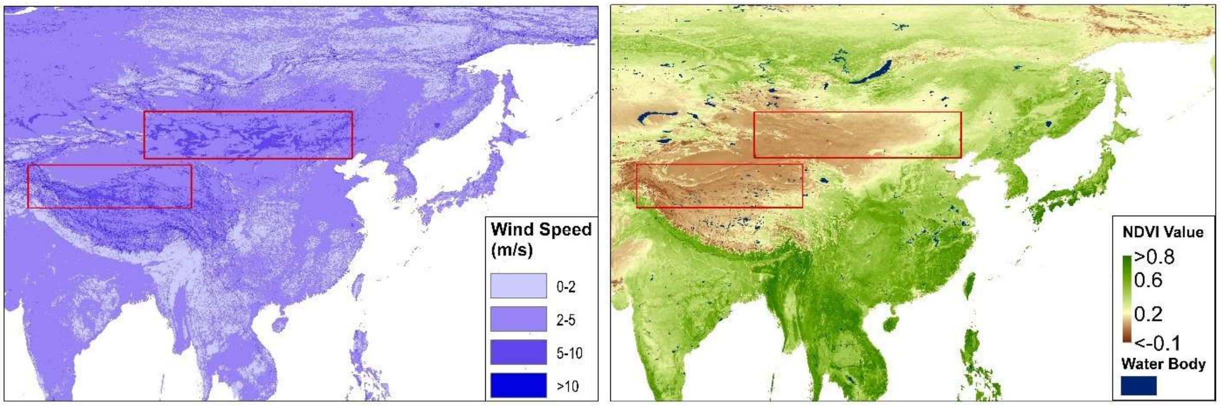
Source: ESCAP (2022) Climate Change and Desertification, Land Degradation and Drought in North-East Asia

3.3 Wind Speed

In North-East Asia, climate change is generally expected to slightly reduce wind speeds (IPCC, 2021; Seneviratne et al., 2021)**, but areas already affected by wind erosion will likely continue experiencing high wind speeds.** Higher wind speeds can increase soil erosion, leading to the loss of fertile soil layer necessary for vegetation (Wang et al., 2017). Wind erosion can also uproot plants and damage the vegetation cover that protects the soil surface and reduces wind speed(Okin et al., 2004). Moreover, dust and sand storms formed by wind erosion can remove abundant soil, reduce land fertility and contribute to desertification (Gillett, 1979; Wang et al., 2017).

Figure 3.3 Average Wind Speed and NDVI

(a) Average wind speed (2008-2017) *(b) Average NDVI (2001-2020)*



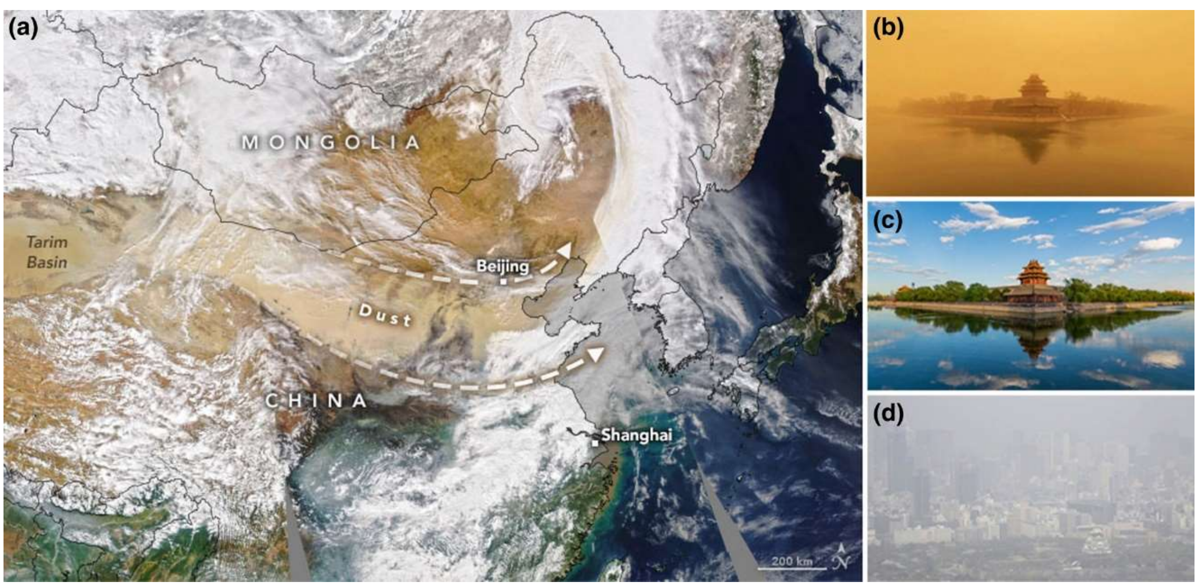
Data Source: Wind speed data from Global Wind Atlas, Available at: https://wad.jrc.ec.europa.eu/ and NDVI data from USGS, Available at: https://lpdaac.usgs.gov/products/mod13q1v006/ (Accessed on 5 August 2024)

Many parts of arid and semi-arid areas in North-East Asia recorded an average wind speed of above 10m/s between 2008 and 2017, indicating the linkage between wind speed and aridity (Figure 3.3). As changes in wind speed associated with climate change can vary in different parts of North-East Asia, it is necessary to monitor developments closely to properly assess the risk of DLD.

Box 3.1 Dust and Sand Storms and Desertification in Mongolia

In arid areas with sparse vegetation cover, high wind speeds can easily lift sand from the ground and transport these particles across vast distances. Strong winds, coupled with droughts and deforestation, often form dust and sand storms and can severely threaten human health, transportation, and economic activities beyond the border.

Between March and April 2021, Mongolia experienced the Mongolian cyclone, the most violent dust and sand storms in a decade, which caused substantial damage both in Mongolia and abroad. During the time, wind speeds in some parts of Mongolia peaked at 30 to 34 meters per second. The northern regions experienced blizzards with mixed snow and ice, while the Gobi grassland areas were hit by strong dust and sand storms. On the 14 March 2021, Ulaanbaatar also suffered from a severe sandstorm. The dust and sand storms also affected neighbouring countries, including China, Japan, and the Republic of Korea.



Note: (a) Satellite image on 15 March 2021, (b) and (c) The northwest corner tower of the Forbidden City in Beijing, China on 15 March 2021 and a clear day; (d) Osaka, Japan on 30 March 2021
Source: (Han et al., 2021).

Conclusion

In North-East Asia, DLD is a significant development challenge that should be continuously addressed with long-term strategies and policies.

DLD is often less prioritized in the national development agenda as it takes long-term efforts and investments to make visible changes. However, DLD has undermined the well-being of 3.2 billion people globally (Scholes et al., 2018) and the threat is expected to intensify due to climate change (Calvin et al., 2023). Moreover, East Asia is one of the regions experiencing the most severe degradation (UNCCD, 2023). Although arid and semi-arid areas in the region slightly decreased from 2001 to 2020, many areas require further attention as climate conditions and socio-economic factors evolve, creating different impacts on DLD. Managing these risks will require a significant amount of time to develop and implement long-term strategies and appropriate measures.

To develop and implement appropriate policies and initiatives to address the risk of DLD in North-East Asia, it is essential to study further possible impacts of anthropogenic drivers and factors, such as animal husbandry, water withdrawals and mining activities.

Increased demand for land-based resources from population increases and economic changes have changed how we use and manage land. Among others, it is alarming that the number of livestock has significantly increased, especially in Mongolia and the northern provinces of China, in association with the rapid increase in meat consumption. Thus, to support risk-informed decision-making in addressing DLD, it is necessary to scrutinize the patterns of animal husbandry in Mongolia and the northern provinces of China and their impacts on DLD. Increasing municipal water withdrawals in China and mining activities in arid and semi-arid areas are also concerns that should be considered.

The impacts of climate change on the geophysical conditions of arid and semi-arid areas should also be assessed at the local level.

Changing climatic conditions add uncertainty to managing DLD. Some areas are expected to see increased precipitation, but the frequency of precipitation could be reduced. Moreover, rising temperatures in most parts of the subregion could significantly impact DLD, decreasing soil moisture and increasing evaporation. Strong winds in arid and semi-arid areas of North-East Asia will likely continue to cause wind erosion, although they may slightly decrease.

However, changes in precipitation patterns, temperature increase, and wind speeds projections will differ significantly from area to area; it is essential to assess the risk of DLD at the local level, reflecting the local conditions and specificities.

Regional and multisectoral cooperation is essential.

As presented in Chapter 1, arid and semi-arid areas in North-East Asia are largely shared among China, Mongolia, and the Russian Federation, while dust and sand storms originating from these regions often impact Japan and the Korean Peninsula. Strengthening regional cooperation to study the risk of DLD, sharing experiences and knowledge, and engaging local stakeholders are common priorities for all member states. This effort also requires expanding the scope of work, utilizing technological advancements, and securing adequate funding support. In this regard, it is encouraging that the leaders of China, Japan, and the Republic of Korea have committed to collaborating with Mongolia to reduce dust and sand storms in East Asia through the 'Trilateral + X Cooperation' framework.[4] Leveraging the recent inauguration of the China-Mongolia Desertification Prevention and Control Cooperation Center in September 2023, further collaboration among the North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC) member States, along with relevant subregional platforms such as the Northeast Asia Network for Desertification, Land Degradation and Drought (DLDD-NEAN), is essential to address these shared challenges.

Improving synergy among relevant sectors through multisectoral collaboration is also necessary. As discussed in Chapters 2 and 3, multiple sectors, from agriculture, animal husbandry, water resources management, mining and forest management, can affect DLD. Accordingly, it is necessary to raise awareness of concerned sectors on the risk of DLD and mainstream the DLD agenda in the policies and practices of these sectors by promoting multisectoral cooperation.

[4] *Joint Declaration of the Ninth ROK-Japan-China Trilateral Summit*

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