The Seventh Session of East Asia Winter Climate outlook
Forum 5−7 November 2019, Ulaanbaatar, Mongolia

Impact of climate change on Environment

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- Using data
- Research methods
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1. Introduction

The entire surface of the Earth is generally warming since 1901, but the warming varies greatly depending on the geographical location.(IPCC 2013)

More warming is observed on the surface of the dry land.

There are numerous researches on climate change in Mongolia and the climate change impacts on the environment and socio-economic sectors and vulnerability assessments were assessed by researchers from each sector and the first Mongolian climate change assessment report was published in 2009. The report is being updated in each 2 years. Researchers also warn that ecosystems are likely to be at risk or to be changed due to global warming, (R.Mijiddorj et al., 2012).

Therefore, we are aiming to study climate change, dryness, surface water scarcity, pasture condition, and changes in important ecosystem components in Mongolia.

Using data

a. Observation data

Daily mean, maximum and minimum air temperature, rainfall data from 1941 to 2018 in 49 meteorological stations and river run-off data about Selenge, Orkhon, Kherlen and Tuul rivers of 1945-2014.

b. Satellite data

computed the average of the highest values of the 1981 to 2015 normalized difference vegetation index (NDVI) for the 8*8 km GSFC / NASA compiled by 9 central stations in Mongolia.

Results (changing air temperature)

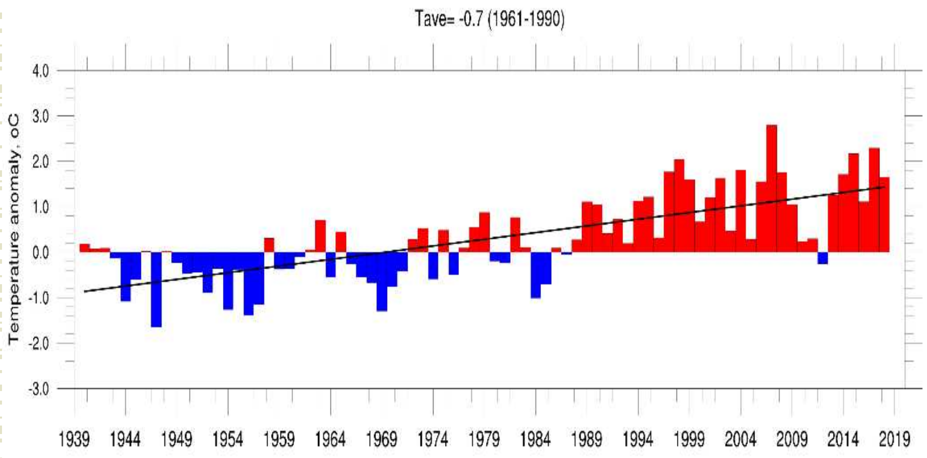


Figure 1. Deviation from multi-year average (1961-1990) of annual mean temperature average of the entire territory of Mongolia periods 1940-2018

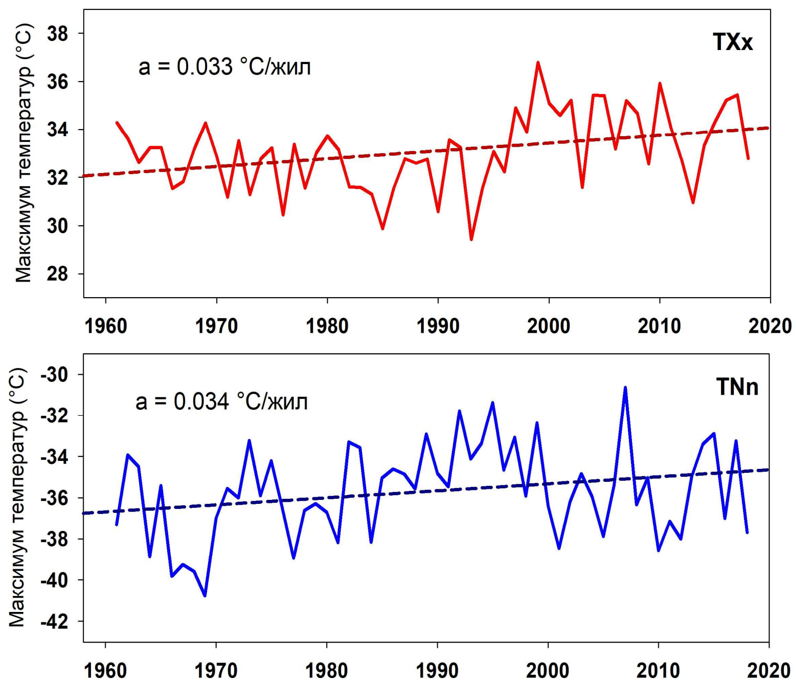
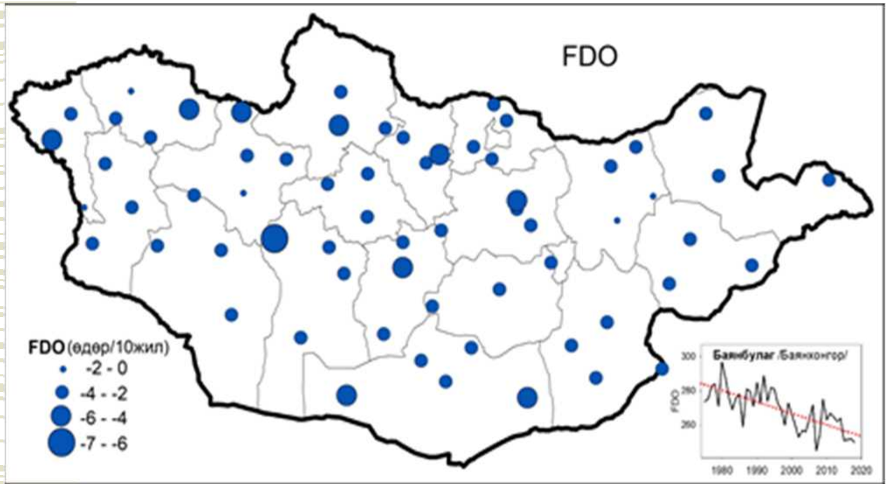


Figure 2. Long term trend of Country-averaged annual mean (a) maximum temperature, (b) minimum temperature

Changing extrem indices



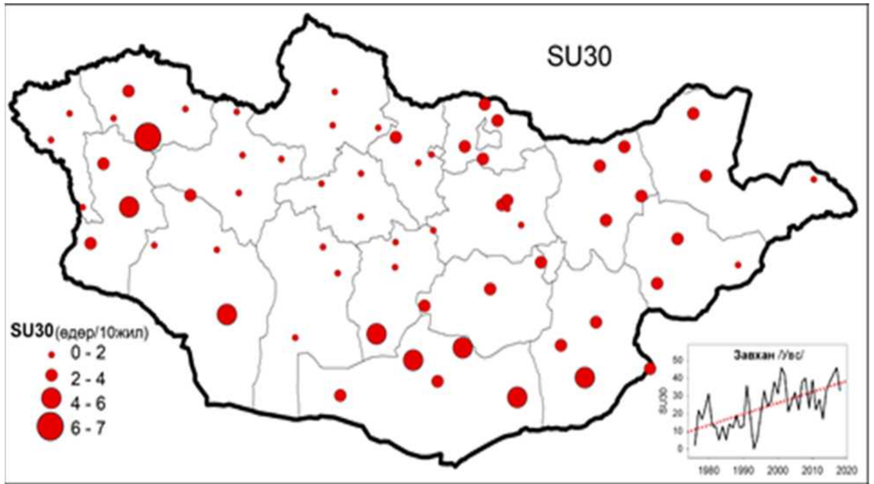


Figure 3. Linear trends distribution in d decade^{-1} of cool days and hot days

FD0-annual count of days when daily minimum temperature <0°C

SU30-annual count of days when daily maximum temperature >30°C

Results (changing soil depth temperature)

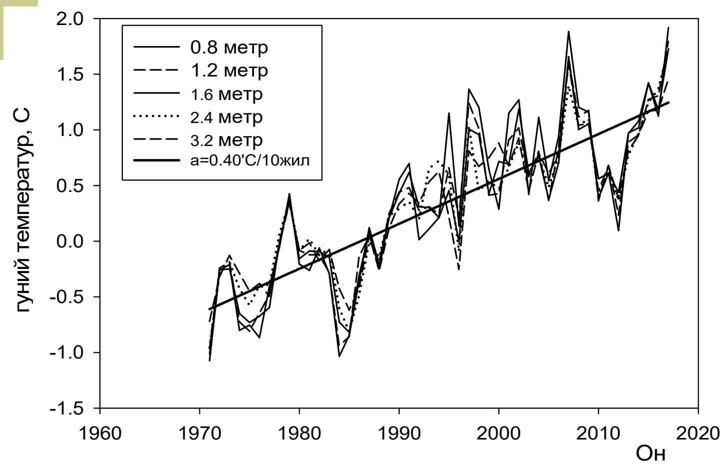


Fig 4. Long term trend of soil depth temperature in Mongolia

One of important indicator of applied meteorology is soil depth temperature. Its feature and change is used to assess for climate change in glacier area and for adaptation measures should be take as early as possible.

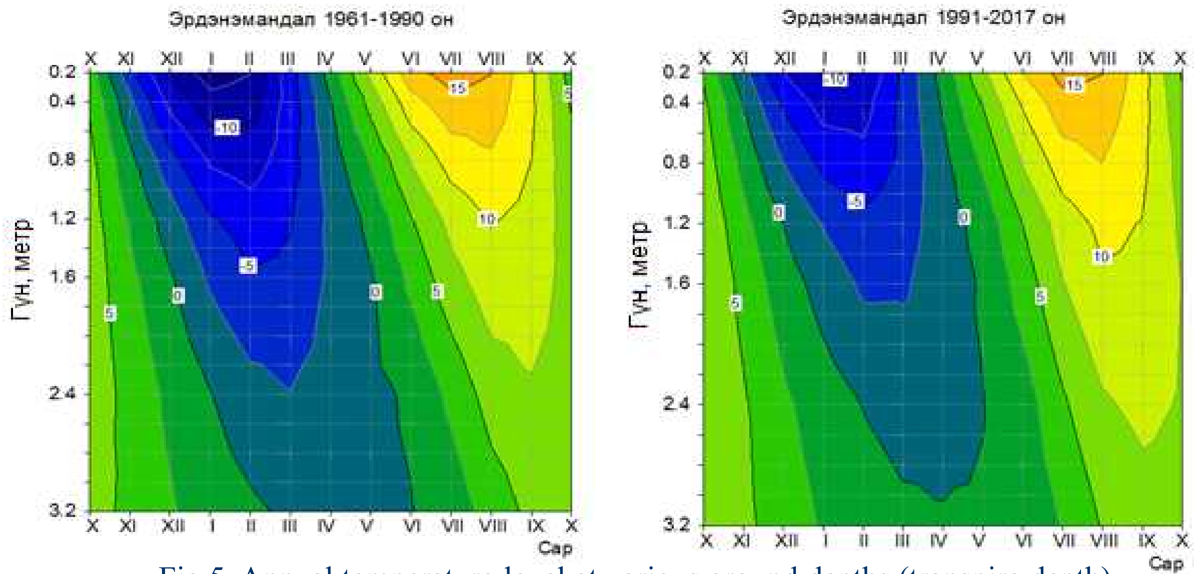


Fig 5. Annual temperature level at various ground depths (transpire depth)

Trend of precipitation

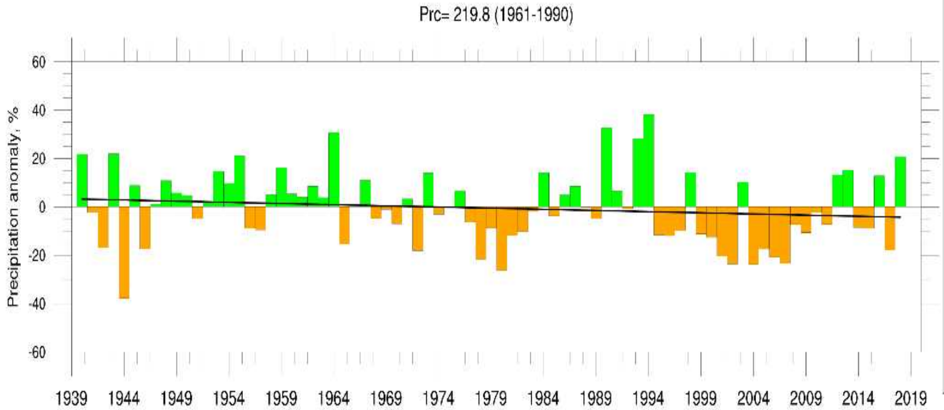


Fig. Long tern trend of annual total precipitation

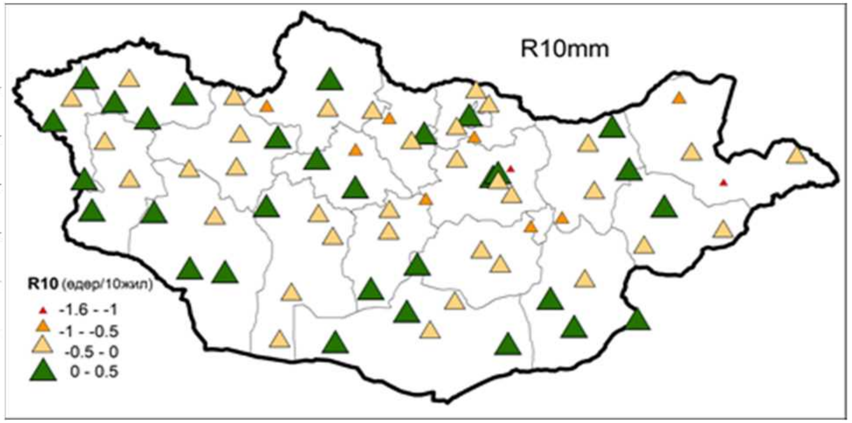


Fig. Linear trends distribution in d decade^{-1} of heavy annual rainfall day

Fig. heavy rainfall July of 25 in 2019, Soginokhairkhan duureg, Ulaanbaatar

Results (drought index)

(SPI) shows the humidity and dryness of the year, and the SPI change in 12-month calculation is an important indicator that affects surface-water diminishing and lake dry-ups.

Classification of the drought by the level of SPI	
SPY level	Classification
1.0<	Extreme humidity
0.5-1.0	High level of humidity
0.31-0.5	Moderate humidity
0.3-(-0.3)	Approximate long term average
-0.31-(-0.5)	medium drought
-0.51-(-1.0)	Strong drought
-1>	Very strong drought

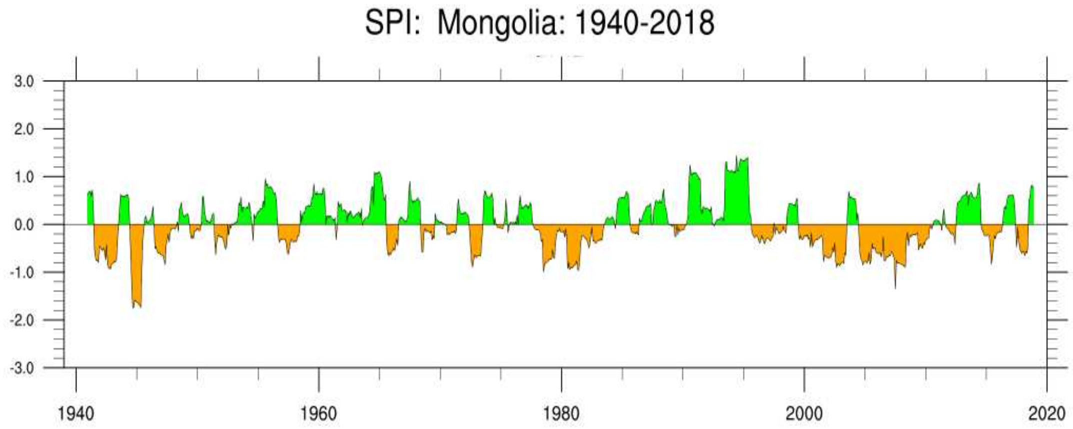
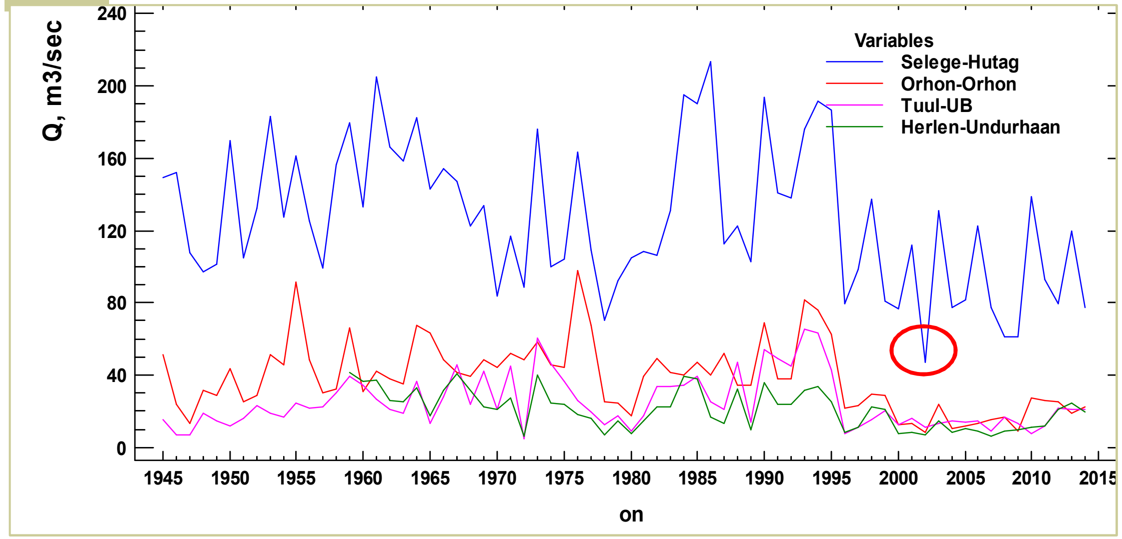


Fig 4. Long term trend of annual SPI12

1997 to 2011, SPI (drought index) was from -0.5 to -1 (strong drought)- rivers and lakes were drying up. However, the SPI Index of 2012-2014, 2016 and 2018 were 0.6- 0.8, indicating years with a high level of humidity, and the likelihood of flooding, river and ponds run-offs were higher.

1. Stream (Run-offs) of large rivers



2002 it was only 47.1 m3

6.1 m3 /sec in 2007

Figure 4. The run-off of Selenge, Orhon, Tuul and Kherlen Rivers of 1945-2014 (Q, m3 / sec)

The Orkhon River's average runoff is about 40 m3 / sec at the Orhon-Orkhon station, while it was only 10.3-11.8 m3 / s during the last dry period in 2003-2004, which is the lowest value of the 67-year observation. During this time, the Red Waterfall has been dissolved now and then.

2. Agro-ecosystem condition

The status of pasture and agriculture is considered as a condition of agro-ecosystem. In the agro-meteorological study of the Russian, when assessing the condition of agro-ecosystems heat-humidity indices (HHI) by G.T. Selyaninov is widely used.

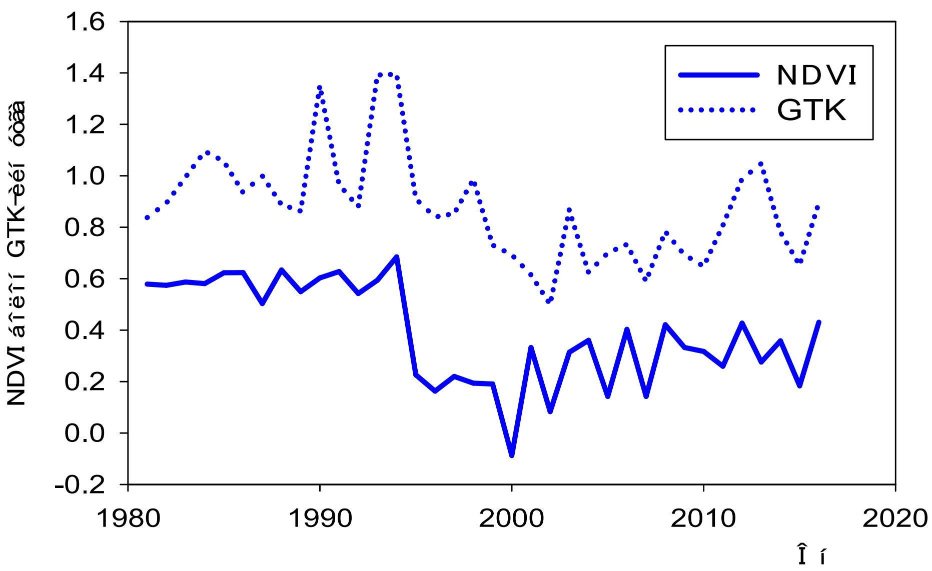


Figure 5. Long term trend of annual NDVI and HHI

$$HHI = \sum P_{>10\,c} / 0.1 \sum T_{>10c} \qquad (1)$$

34-year correlation of these two variables shows that R = 0.64, R2 = 41.7 indicates that the HHI well represents the pasture agro-ecosystem.

2. Agro-ecosystem condition

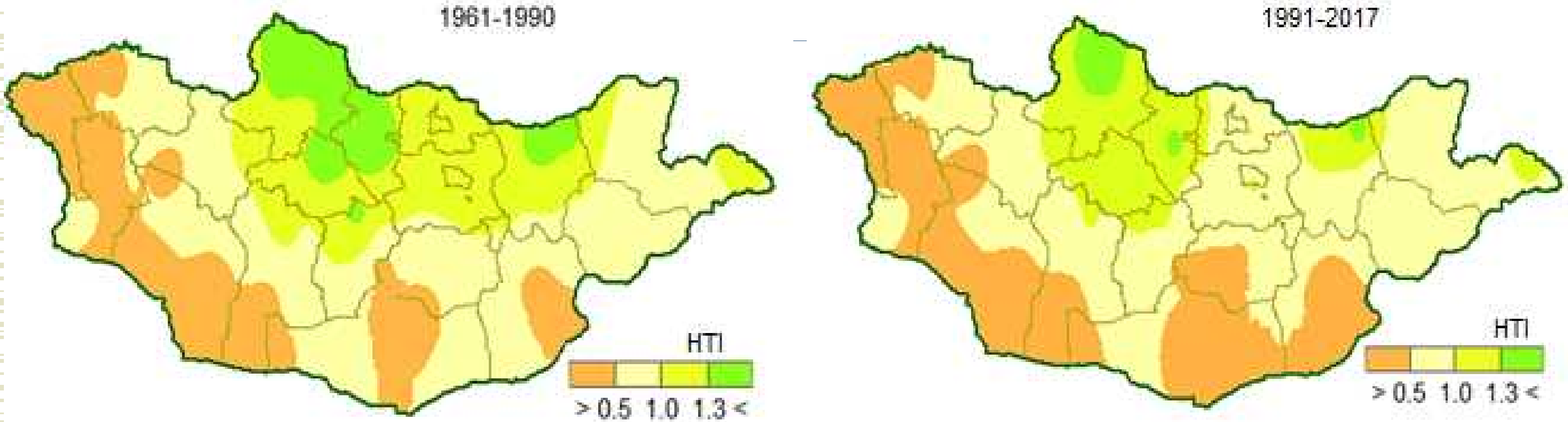


Figure 6. Geographical distribution of the average value of the HHI

(>0.5-dry, 0.5-1.0 deficit moisture, 1< enough moisture)

intensive climate change in 1991-2017, the area of degraded steppes with the value of HHI 0.5-1.0 and dry Gobi areas with the value of HHI less than 0.5 have increased. In other words, the land area of dry Gobi has increased by 4% expanded to the north, whereas the relatively humid forest steppe area has also been reduced by 3% moving to the north.

SUMMARY

- Annual average air temperature of Mongolia was warmed by 2.25 ° C between 1940 and 2018, even though the annual sum of precipitation has not decreased significantly, there has been a slight decrease in overall trend.
- During these long periods of low precipitation, the drought index SPI was between 0.5 and -1, indicating these were extreme dry years, which resulted in the runoff of bigger rivers was less than the last 30 to 40 years, and hundreds of small rivers, lakes, ponds and lakes dried up, more than 70 percent of the total territory was in land degradation.
- Increased global warming from 1998 to 2011 had resulted in precipitation lower than normal for many years, and Mongolia's pasture and agricultural ecosystems were degraded and around 90 percent of the area was dry and drought.

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Thank you for attention